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ORAL AND WRITTEN WISHES OF RURAL AND CITY SCHOOL CHILDREN[1]

GEORGE S. SPEER[2]

The wishes of both adults and children are indicative of the things which they believe they lack. They express the things which the individual desires and the direction in which the individual is struggling. They may be significant in the diagnosis of the maladjustments with which they struggle, or they may be of interest in revealing the attitude the child has towards his problems. (1)

Many studies have been published dealing with the wishes of children, adults, delinquents, age groups, and so on.

The diagnostic value of a wish, however, depends upon its sincerity and the degree to which it differs from the norm of wishes from individuals of the same age, sex, grade, economic status, and environment. As Washburne (3) has indicated, and as we have previously found (2), there is little tendency for the subjects to misrepresent wishes when the examiner is careful in his approach and sincere in his purpose.

The question of approach is an important one and may affect the validity of the replies. That is, if one type of approach elicits one type of response and another type elicits another response, neither of the responses may be considered indicative of the goal or need of the individual, but rather as artifacts of the question-answer situation. If, on the other hand, two different approaches elicit the same response, the response may be tentatively accepted as indicative of the direction of the desires of the individual.

This paper reports the study of wishes expressed by school children first in writing, and later in an oral interview. Two problems are involved: 1. Does the manner in which the wish is expressed affect the content of the wish? 2. Do rural and city school children express similar wishes?

METHOD

The method used in obtaining these expressions has been to ask the children to write their answer to the question, "If anything you wished would come true, what would you wish?" The question was read by the regular classroom teacher in the classroom, without the children's knowledge that anyone other than the teacher was interested. Later in a personal interview, the same question was repeated by the examiner and the child's answer recorded. In this study no account has been taken of the lapse of time between the written and oral expression. The personal interview usually occurred within two months after the written expression was obtained.

SUBJECTS

Expressions of wishes were obtained from 115 children in city schools, sixty-five boys and fifty girls; and from seventy-six children in rural, one-room schools, thirty-seven boys and thirty-nine girls. The children in both groups range in age from seven to fifteen, from grades three to eight.

CLASSIFICATION OF RESPONSES

The wishes obtained were classified according to the central idea of the wish.

[1] *From the Child Guidance Service, Children's Service League, Springfield, Illinois.*

[2] *Read at the 14th Annual Meeting of the Midwestern Psychological Association, Lincoln, Nebraska, May 5th, 1939.*

CHILD DEVELOPMENT, Vol. 10, No. 3 (September, 1939)

First, the personal wish. In this category we placed all wishes where the idea or purpose of the wish was distinctly personal and individualistic, or where the thing desired was intangible or presumably of no value to another. For example, such wishes as "that my asthma was cured," "that I could run fast," "that I was beautiful," and similar expressions have been classed as personal.

Second, the group which we have called "the wish to have things." These wishes are expressions of desire for tangible, valuable, transferable objects. We may perhaps be accused of some looseness in classification when we admit that we place in this category the wish for "the most beautiful wife in the world." Because of the age of the boy who expressed the wish, however, (10), we felt that this represented a tangible rather than a personal and intangible good. Similar wishes are those for a pony, a dress, a yacht, or a million dollars.

The third group is the wish to become something or someone. This includes the true vocational ambitions as they are expressed, and those quasi-vocational desires which might almost be classed as personal, but which we have, perhaps arbitrarily, included in this group. Examples of these wishes are the wish to become an aviator, a cowboy, a prince, a movie star, or a ditch digger.

The fourth category includes all those wishes which appeared to us to represent a desire on the part of the child for the good or benefits to accrue to someone else. These are, as far as possible, the opposite of the personal wish, and might be called "unselfish" wishes. It is sometimes difficult to decide whether a child is wishing for someone else, or for himself. Such a wish as "that my parents have a nice home" might be in reality a concealed desire for a nice home for the child. However, we have, again somewhat arbitrarily, included such wishes with those more obviously for other people, such as "that the cripple can walk again" or "that my grandfather's neck gets better."

A fifth category, which we had not anticipated, became necessary. This is the wish for world peace.

GROUP DIFFERENCES

Comparing the responses of rural and city school children, we found that rural school children were more consistent in the two expressions than the city children. Consistency is measured in percentage of children making the same type of wish in both written and oral expressions. In all but one category, rural children showed less variation than the city children. The variation by category was slight for both groups, however, and, except in one classification, was insignificant. See Table 1.

TABLE 1

PER CENT OF CHILDREN EXPRESSING THE SAME TYPE OF WISH IN ORAL AND WRITTEN STATEMENTS

Group	Type of wish				
	Personal	To become	To have things	For other people	World peace
City	83*	86	69	78	96
Rural	87	91	72	33	95

*To be read: 83% of the city children who expressed personal wishes on the written statement expressed the same type of wish on the oral statement.

City children expressed more wishes about other people in the oral statement than in the written; rural children expressed more wishes about others in the written statement.

We also considered variations in wishes within the categories. Personal wishes for both groups were relatively constant and unchanged. Both groups

showed a fairly high proportion of change in "things to have" and "things to become," with the city children showing the greatest degree of change. That is to say, approximately the same number of wishes of rural children are classified as "things to have" or "things to become" on both the oral and written statements, but 38 per cent of the "things to have" and 26 per cent of the "things to become" are different in the oral statement. Sixty-nine per cent of the city "things to have" and 57 per cent of the "things to be" were different on the oral report.

This might suggest that the rural child is exposed to fewer things which he might desire than is the city child, and also that the range of possible vocations is smaller, so that the rural child is less likely to be swayed in his choice of occupations by the introduction of alternate types of livelihood.

SEX DIFFERENCES[3]

In both the oral and written expressions, girls exceeded boys in the desire to have things, and in personal wishes. Girls also expressed more wishes relating to other people than boys. Boys expressed more vocational ("to become") wishes than girls and, also, more than twice as many wishes for peace.

AGE DIFFERENCES

Interested in whether these wishes were affected by age, we divided our subjects into four age-sex groups. We have fifty-two boys, eleven years or over; fifty boys under eleven. There are forty-nine girls eleven or over, and forty under eleven.

The tabulation of the wishes is presented in Table 2.

TABLE 2

PER CENT OF WISHES IN EACH CLASSIFICATION

	Personal	To become	To have things	For other people	World peace	Immediate	Future
All boys	11.7	10.2	65.8	7.7	4.6	95.0	5.0
All girls	14.0	5.7	67.5	10.7	2.1	96.5	3.5
Older boys	15.0	9.6	62.8	6.6	5.6	93.6	6.4
Younger boys	7.3	8.9	71.2	9.3	3.1	96.8	3.2
Older girls	17.3	7.8	59.0	12.8	2.8	96.8	3.2
Younger girls	10.3	6.4	75.4	8.3	1.2	96.1	3.9

The older children of both sexes expressed a greater percentage of personal wishes. The order in which personal wishes were expressed is Older Girls, Older Boys, Younger Girls, and Younger Boys. There seems to be here both an age and a sex factor, as the girls at both age levels expressed more personal wishes than the boys.

The younger children of both sexes expressed the largest percentage of wishes for things. The order in which wishes for things are expressed is Younger Girls, Younger Boys, Older Boys and Older Girls. Again, there appear to be both age and

[3] *Oral and written wishes are considered together in the examination of sex and age differences.*

sex differences, the girls expressing more wishes for possessions than the boys, and the younger child expressing more than the older one. Slightly more than 75 per cent of the wishes of younger girls were for "things to have."

As noted above, boys expressed more vocational, "things to become," wishes than girls. This was true of both age groups. Again, however, the differences appeared to be due to both age and sex factors, the older boys expressing more vocational wishes than the younger boys, and the older girls more than the younger girls. The order in which wishes of this classification are expressed is Older Boys, Younger Boys, Older Girls, and Younger Girls.

The Older Girl expressed nearly twice as many wishes relating to other people as did the Older Boy. The differences in this category do not seem to follow any clear cut sex or age pattern, as the other three groups show no marked trend. The order is Older Girl, Younger Boy, Younger Girl, and Older Boy.

The order in which wishes for peace are expressed shows both age and sex differences. The closer the age-sex group comes to the possibility of contact with war, the greater is the expression of a desire for peace. The order in which wishes were expressed is Older Boy, Younger Boy, Older Girl, and Younger Girl.

TIME RELATIONSHIP

We also classified the wishes in relation to the time the thing was desired; that is, present or future. None of the children expressed a wish relating to the past; that is, that something had or had not happened in the past. This may be due to the phrasing of the question.[4]

At all ages, and for both sexes, the great majority of wishes were classified as "immediate" rather than "future". Girls, who wished for things to have, expressed more immediate wishes than boys who, as has already been pointed out, were interested in their vocational future. Younger children of both sexes expressed more immediate wishes than the older children.

MISCELLANEOUS WISHES

Many of the wishes expressed are unusual. We cannot consider all of these, but there are some which, it is felt, deserve at least passing notice.

As is to be expected, a number of wishes for money were expressed. It is interesting to note that, although girls expressed more wishes to have things, boys expressed twice as many wishes for money. There are both age and sex factors here, apparently, as the order of expression is Older Boys, Older Girls, Younger Boys, and Younger Girls. It is also interesting to note that the boys were specific in the <u>amounts</u> of money desired, as "five cents," or "one billion dollars;" but girls tended to be general in their expressions, wishing "to be rich," "to have a lot of money," or "to be wealthy." Boys also wished for a great deal more money than girls. When we consider the wishes where specific amounts of money are named, we find that the median request of girls is for fifty dollars, with a range from one dollar to two million; the median request of the boys is one million dollars, with a range from one cent to one hundred billion dollars.

A number of girls expressed wishes for love, two of them qualifying this by adding "in the right way." No boy wished for love. On the other hand, a number of boys expressed wishes for wives - variously requiring them to be the most beautiful, good cooks, the nicest, and so on. No girl wished for a husband.

[4] *In a previous study (2) the question was phrased somewhat differently, and wishes relating to the past were obtained.*

SUMMARY

Summarizing these results, we find that both rural and city children were fairly consistent in the expression of wishes in oral and written statements. Rural children were somewhat reluctant to express wishes about other people in the oral interview, but expressed more of this type in writing. Rural children were more consistent in their wishes than city children.

Girls expressed more wishes for things, personal wishes, wishes about other people, and more immediate wishes than boys. Boys expressed more "to become" wishes, more wishes for peace, and more wishes for money, and for larger amounts of money than girls.

Older children expressed more personal and "to become" wishes than younger children, who expressed more immediate wishes and more wishes for things.

CONCLUSION

The consistency of the expressions obtained in response to two different approaches, leads us to believe that we have obtained reliable and valid indications of the desires and goals of our subjects. In this experiment, the manner of obtaining the wishes did not seriously affect the content of the wishes expressed.

The fact that social and cultural differences produced less differences than age and sex of subjects leads us to conclude that, for this group, age and sex are most important in determining the type of goal or desire, and that social and cultural differences may affect the specific object of desire.

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THE USE OF THE STANFORD-BINET (1937 REVISION) IN A GROUP OF NURSERY SCHOOL CHILDREN[1]

IRMA SIMONTON BLACK

This article is based upon the use of the new Stanford-Binet in a nursery school for the past two years. All of the testing for the study was done at the Harriet Johnson Nursery School, 69 Bank Street, New York City. The testing was done by Rose E. Bliven, and the writer.

Since the publication of the revised edition of the Stanford-Binet scale in the spring of 1937, the psychological staff of the Bank Street Schools have used this test in conjunction with the Merrill-Palmer scale of performance tests in the examination of the nursery school children. Some of the preliminary findings as to the relation of the new Stanford-Binet with the Merrill-Palmer, and its reliability on retests in this situation, will be presented, together with a discussion of the new Stanford-Binet as a preschool test.

For purposes of clarity and convenience the statistical work in the new test will be presented first, followed by an evaluation of the new Stanford-Binet as to its usefulness with preschool children.

PREVIOUS FINDINGS

While no correlations have been offered on the new Stanford-Binet as to relation to other tests, it is essentially the same type of test as the old Stanford, and the Kuhlmann-Binet, so that we might expect to find the relationships of this test to other preschool tests to follow along the same general lines as the Kuhlmann-Binet, for instance.

The majority of experimenters have found the relationships of scores on preschool tests to be low. Driscoll, using the I.Q. scores, obtained correlations between the Kuhlmann-Binet and Merrill-Palmer ranging from .55 to .76 on a group of 293 children ranging from 21 months to 51 months. On a group of 100 children, 33 to 39 months old, Rust found a correlation of .60 on the same tests. Wellman, using both the old Stanford-Binet and the Kuhlmann-Binet as compared with the Merrill-Palmer, obtained a correlation of .52 on 341 children ranging from 18 months to 65 months. Broken up into smaller groups her correlations ranged from .45 to .63.

When the mental age was used as a measure, as in the work of Stutsman and Kawin, the figures are naturally higher, since the factor of chronological age is not held constant as it is by the use of partial correlation, or by the use of the Intelligence Quotient (which eliminates the effect of C. A. for the individual instead of for the group). Stutsman found a correlation of .79 between the mental age scores of the Merrill-Palmer and the Stanford-Binet on a group of 159 children in the standardization group. In a group of 115 nursery school children she obtained a correlation of .78. These are similar to Kawin's correlation of .78 in a group of 55 children.

The studies which have been done on retests of preschool scales show a very similar picture to the above - a relationship that is positive but low for predictive purposes. Actual correlation figures on retests in Driscoll's study range from .58 to .80 on the Kuhlmann-Binet scale, and from .39 to .60 on the Merrill-Palmer scale. These retests were done over six and twelve month periods.

Wellman's figures are similar for these tests, ranging on Kuhlmann or old Stanford-Binet from .61 to .65 over six and twelve month periods, and from .50 to .73 on the Merrill-Palmer for the same intervals. Kawin reports a correlation of .59 on raw scores between Merrill-Palmer retests, when chronological age

[1] *The study was made for the Studies and Publications Department of the Bank Street Schools, 69 Bank Street, New York City.*

CHILD DEVELOPMENT, Vol. 10, No. 3 (September 1939)

is held constant. The interval ranged from 2 to 29 months; the age from 25 - 57 months. For the Kuhlmann-Binet, Kawin's correlation in retests for 114 children retested at 10.6 months was .75. Stutsman, working with sigma scores, reports a correlation of .59 over a period of 6 to 9 months, with children 2 to 5 years old, on retests of the Merrill-Palmer scale. Goodenough reports a higher correlation (.82) on the Kuhlmann-Binet scale for her entire group of 300, over the briefer interval of six weeks.

The findings to date have been in general agreement in finding a positive, though rather low relationship both between different preschool scales, and between retests on the same scale. The correlations are sufficiently high to show a definite relationship and sufficiently low to render their predictive value questionable for an individual child. In general the correlations between retests on Binet scales has been slightly higher than between retests on the Merrill-Palmer scales. We will discuss this question in connection with the figures of this study.

Wellman's work has been of great importance in clarifying the effect of nursery school attendance upon test score. We must be very clear in work with preschool tests that the nursery school experience itself is a factor which may be causing significant and valid changes in the child's status so that any given test may appear less reliable than it is. In this study we have separated the groups according to extent of nursery school experience in order to isolate the effect of nursery school experience upon the relationships of the test, so that they will be influenced in an orderly way.

THE STUDY

The first part of this section will be devoted to a discussion of results obtained from testing a group of 31 incoming children, and a group of 35 children with six months or more of nursery school experience, on both Stanford-Binet and Merrill-Palmer scales. These were all first tests.

The second part of this section will deal with retests made at the end of the first year of nursery school, (on children who took the first test shortly after entering) also with retests given the following year to those children who had their first test after a year of nursery school.

The Harriet Johnson Nursery School is a private nursery school in the Greenwich Village section of New York City, which draws almost entirely from professional families for its children. It is a highly selected group both as to family background, and as previous tests had already shown, in I.Q. status.

The school during 1937-38 had an enrollment of 70 children, ranging in age from two to six years. The children are divided into six groups according to age, each with an age-range of less than a year.

In all groups, half of the children were given the Stanford-Binet first, the other half the Merrill-Palmer. This was done in order to eliminate any differences in reaction due to initial self-consciousness in the first test or fatigue in the second. When possible, both tests were administered in the same morning, but when the child showed signs of fatigue or restlessness, the examination was broken up into two periods. These periods were usually on succeeding days, and always within the same school week.

In comparisons of the Stanford-Binet and the Merrill-Palmer, the intelligence quotient was used for both tests in order to get comparable results. Although Stutsman warns against the use of the I.Q. as a score, various investigators have decided in favor of it because of its convenience. Wellman, for instance, analyses Stutsman's figures and concludes "The results of the present study indicate that the intelligence quotient is as useful and adequate a score as sigma score (standard deviation in terms of raw score) or percentile rank. There appear to be some inadequacies in the original standardization group and

in the method of deriving scores from the raw scores. So far as the present study contributes anything to this problem, it would appear that the difficulty is not restricted to any one derived score but applies to all."

The children coming into the nursery school in the fall, with no previous nursery school experience, were tested within six weeks of their entrance on the Stanford-Binet and the Merrill-Palmer tests. This group was composed of 31 children ranging in age from twenty-four to fifty-six months.

2 years - 15
3 years - 12
4 years - 4

This group of new children was compared with a group of 35 children who were tested for the first time after having nursery school experience. Of this group 11 of the children were tested at the end of their first year of school (or a minimum of six months' nursery experience) and the remaining 24 were tested for the first time in the spring of their second year or after a minimum of a year of actual nursery school attendance (exclusive of summer vacations). These groups were considered together because of the small numbers, on the assumption that the first year of nursery school would be likely to be the most productive of change.

The age distribution of this group was as follows:

2 - 3	3
3 - 4	14
4 - 5	18

The age distribution, although overlapping almost in its entirety, is more heavily weighted at the younger levels for the new children, and at the older levels for the children with nursery school experience. This is almost inevitable, as the majority of the new children are entering the younger groups. This factor of age might be eliminated by working with new and "old" nursery school children of the same age, as for instance the three-year-olds, but in most nursery schools the small numbers make it difficult to get age-groups of statistically significant size under a period of years.

The results obtained from the tests made on the incoming children are shown in Table 1.

TABLE 1

31 NEW CHILDREN TESTED ON STANFORD-BINET AND MERRILL-PALMER

	No.	C.A. range	I.Q. range	Mean I.Q.	S.D.	r*
Stanford-Binet	31	24-54 mo.	95-146	121.70	13.1	
Merrill-Palmer	31	24-54 mo.	89-169	115.55	16.2	.36

*The Pearson product moment method of correlation is used throughout.

The outstanding contrast in this group of tests is the markedly higher mean I.Q. of the Stanford-Binet test, the chances being 76 to 1 that the difference is a significant one. The relationship between the tests is also rather low. Let us compare the results from the incoming group with those of children whose first test was given after a minimum of six months' nursery school experience. Since this group of children was comparable to the group of new children in family background, and social status, we may consider the nursery school experience as the one factor lacking in the new group and common to the group with nursery school experience.

The results of this latter group are shown in Table 2.

TABLE 2

35 CHILDREN TESTED AFTER NURSERY SCHOOL EXPERIENCE. (FIRST TEST)
11 CHILDREN WITH SIX MONTHS OR MORE OF NURSERY SCHOOL
24 CHILDREN WITH ONE YEAR OR MORE OF NURSERY SCHOOL

	No.	C.A. range	I.Q. range	Mean I.Q.	S.D.	r
Stanford-Binet	35	30-60	109-172	131.2	13.5	
Merrill-Palmer	35	30-60	107-159	129.8	13.4	.64

These figures show a higher average I.Q. on both scales, and less of a divergence in Merrill-Palmer and Stanford-Binet results. While the new children had a mean I.Q. 6.2 points higher on the Stanford-Binet than on the Merrill-Palmer, the children with nursery school experience have a mean I.Q. on the Stanford-Binet only 1.4 points higher than the mean Merrill-Palmer I.Q. This difference is not statistically significant, the standard error of the difference being greater than the difference itself.

To approach this problem in another way, the children with nursery school experience have a mean Merrill-Palmer I.Q. 14.3 points higher than the incoming group. On the Stanford-Binet scale, the mean I.Q. of the children with nursery school training is 9.5 points higher.

We will postpone discussion of these results until after examination of the retest results of 27 of the incoming children.

TABLE 3

27 RETESTS ON STANFORD-BINET AFTER SIX MONTHS OF NURSERY SCHOOL

	No.	C.A. range	I.Q. range	Mean I.Q.	S.D.	r
Stanford-Binet (fall)	27	24-50	95-146	122.1	12.45	.80
Stanford-Binet (spring)	27	30-56	91-151	128.1	13.05	

The same children who were tested within six weeks of entry in the fall were retested on both scales the following spring. At the present writing 27 of these cases are available for study (Table 3). These children, who in the fall had a mean Stanford-Binet I.Q. score of 122.1 earned a mean I.Q. of 128.1. This difference, according to McCall's experimental - coefficient method, is statistically significant, the chances being over 369 to 1 that it is a true difference.

This group compared with the group of 35 cases first tested after at least six months or more of nursery school experience (Table 2) shows marked reduction of the difference in I.Q. level, and would indicate that there was no original discrepancy in the ability of the new children and the "old" nursery school children. In six months, 27 children made a mean gain of 6 I.Q. points on the Stanford-Binet scale. The "old" children on the first test showed a mean I.Q. nearly 8 points higher than the new group, but on the other hand, a majority of these children had had well over six months of nursery school experience.

The correlation between first test and retest after six months for the 27 new children was .80, a relatively high figure for a preschool test, particularly over a period of radically altered environment. This appears to reflect a characteristic stability of the new Stanford-Binet as compared with other preschool tests.

The figures for the Merrill-Palmer first tests and retests upon the same group of children are shown in Table 4. These were worked out in order to have comparative data on the same group of children. Here, as in the Stanford-Binet, the results are similar to the results of first tests of children with nursery school experience.

TABLE 4

27 RETESTS ON MERRILL-PALMER AFTER SIX MONTHS OF NURSERY SCHOOL

	No.	C.A. range	I.Q. range	Mean I.Q.	S.D.	r
Merrill-Palmer (fall)	27	24-50	89-169	116.9	15.94	.58
Merrill-Palmer (spring)	27	30-56	95-161	134.4	16.15	

The mean Merrill-Palmer I.Q. of the incoming group is 116.9, after six months of nursery school it rises over 16 points to 134.4 (the first test of children with nursery school experience gave us a mean I.Q. of 129.8). The correlation between first and second test for this group was .58, which is in general agreement with the figures of other investigators of this test (Driscoll, Wellman, Kawin).

This rise from 116.9 to 134.4 is, of course, statistically significant. The experimental coefficient of this difference is over 1.5, which according to McCall indicates a 67,000 to 1 chance of there being a significant difference.

The higher mean I.Q. on the Merrill-Palmer scale of the retest group as compared to the first test of children with previous nursery school experience probably results from the practice effects commonly noted on the Merrill-Palmer scale (Wellman).

The difference between the mean I.Q.'s on the Stanford-Binet and Merrill-Palmer scale of the spring retest group is large enough to have a 76 to 1 chance (McCall's experimental coefficient) of being statistically significant, whereas the difference between the mean I.Q.'s on the Stanford-Binet and Merrill-Palmer scale for the children with previous nursery school experience is not significant.

In order to obtain a figure on Stanford-Binet correlation between first test and retest which would be less influenced by the first effects of nursery school experience, a group of 29 children was tested for the first time after at least one year of nursery school, and was then retested in the spring one year later (within 12-16 months).

TABLE 5

29 RETESTS ON STANFORD-BINET AFTER AT LEAST ONE YEAR OF NURSERY SCHOOL, PRIOR TO FIRST TEST

	Age - range	I.Q. range	Mean I.Q.	S.D.	r
Stanford-Binet (1938)	2½ - 6½ yrs.	101-172	130.4	2.86	.94
Stanford-Binet (1939)	3½ - 7½ yrs.	105-172	130.8	2.74	

This group is of somewhat different character than the original group of children with at least six months of nursery school experience, as in the 1938 group we included the five-year-olds who were too old for testing in the Merrill-Palmer. It was the first test on the Stanford-Binet scale for all of the children, although four of the five-year-old group had been tested two years previously on the Kuhlmann-Binet and the Merrill-Palmer.

The ages ranged as follows:

1938 test		1939 test	
Age	Cases	Age	Cases
2½ - 3	1	3½ - 4	1
3 - 4	12	4 - 5	12
4 - 5	7	5 - 6	7
5 - 6	7	6 - 7	6
6 - 6½	2	7 - 7½	3

In the case of the five-year-olds, retests were done on 10 of the children who had left the nursery school but who were attending two affiliated schools in the neighborhood where there is a curriculum of progressive nature similar in general outline to the nursery school curriculum.

At the time of the first test in the spring of 1938, this group ranged from 101-172 in I.Q. with a mean I.Q. of 130.4. The following year, in 1939, this group ranged from 105-172 with a mean I.Q. of 130.8. This difference is not significant. This figure represents small gains and small losses, with more children gaining than losing and with an average gain slightly higher than the average loss. The picture is a far more static one than any we have yet seen over a similar period on a preschool test. The reliability was the surprisingly high figure of .94, a result which again would indicate that the new Stanford-Binet is a more reliable test for preschool ages than previous ones.

In the light of these various results, we may consider the new Stanford-Binet as a preschool test.

The new Stanford-Binet, though unquestionably affected by the experience of the preschool child, is more stable than the Merrill-Palmer in retests, and appears to be somewhat less affected by the factor of nursery school experience in this group. In part, this may be accounted for by the nature of the group tested, but there are indications that this feature of the test would appear in other situations as well. The regularity and consistency of the change of I.Q., the stability of I.Q. of a group of children outgrowing the preschool years, the relatively high correlation of the first test and retest even over a period of change, indicates that this is a relatively precise measuring instrument. One of the reasons for this may be the comparative remoteness of the Stanford-Binet items from the daily life problems of the child, which would result in a less direct effect of changing experience upon test score. On the other hand, the problems encountered in the formboards and puzzles of the Merrill-Palmer are similar enough in type to the problems encountered in block building, clay work, to make nursery school experience of this type almost a training experience for the Merrill-Palmer test. (Incidentally many of the new puzzles and games such as picture lotto, put out by educational toy concerns are so similar to the Merrill-Palmer test items as to invalidate the results on this scale where a child is known to have had such equipment at home. No attempt was made in this study to ascertain this, but it is a serious problem, as these toys are increasing in number and attractiveness).

The Stanford-Binet also has one great advantage over the Merrill-Palmer scale in that it does not stop short at the end of the preschool period. This feature of the Merrill-Palmer makes it unreliable for "older" nursery school age children of average or near-average ability, and doubtful for gifted children much younger than that. Stutsman says, "While the 54-59 month age group shows only a slight truncation at the upper end of the distribution, the tables of standard deviation show truncation much earlier than this."

The new Stanford-Binet in this study shows the same tendency to reflect such environmental changes as nursery school attendance as Wellman found for the Kuhlmann-Binet and the old Stanford-Binet. Test results on both the new Stanford-Binet and the Merrill-Palmer show a decided increase with experience in nursery school, with a sharper rise on the Merrill-Palmer scale than on the new Stanford-Binet, and a closer agreement between the two scales after nursery school than before. This is in apparent disagreement with Wellman's findings on the Merrill-Palmer and the Kuhlmann-Binet, where she reports more effect of nursery school experience on the Binet type scale. This result may be in part characteristic of the new Stanford-Binet as compared with previous tests, or it may be explained in part by the nature of the group tested and the type of experience they have in the nursery school.

Our group is composed of city children, the majority of them from 1 or 2 child families, who live in small apartments and play under almost constant adult supervision. This background of intimacy with adults plus lack of opportunity for unsupervised play and space to play in, might quite logically put our group at an advantage on a test of a more verbal nature such as the Stanford-Binet and at a corresponding disadvantage on a test of performance type like the Merrill-Palmer.

The nursery school experience which these children get puts the emphasis in exactly the opposite direction. The school is very fully equipped with material which gives the child opportunity for the development of motor skills both in outdoor equipment, such as jungle gyms, slide, jumping boards, and indoor equipment, such as blocks, clay, paint. Material such as dolls, and toy animals though used in the school, has always been used in conjunction with plastic materials which offer more creative uses. This emphasis may be in large part responsible for the unusually wide divergence between Merrill-Palmer score of the new and "old" children. The relationship between the two scales changes in a way which seems to confirm the above hypothesis - the low correlation of .36 between the Stanford-Binet and Merrill-Palmer scores of the incoming group being in decided contrast to the correlation figure of .64 for the children with nursery school experience.

SUMMARY AND CONCLUSIONS OF STATISTICAL SURVEY

A study of the new Stanford-Binet was made in the Harriet Johnson Nursery School, New York City. The children were divided into groups according to amount of nursery school experience, and each child was given a Stanford-Binet and a Merrill-Palmer test. The incoming children later were retested on both scales. The children who were given their first test after six months or more of nursery school were retested only on the Stanford-Binet. The comparison between the incoming children and those with nursery school experience, on their <u>first</u> test showed:

(1) The incoming group of 31 children obtained a mean I.Q. score of 121.7 on the Stanford-Binet, and 115.5 on the Merrill-Palmer. The correlation between the two tests was .36.

(2) The group with a minimum of six months' nursery school experience had a mean I.Q. on the Stanford-Binet of 131.2, and on the Merrill-Palmer of 129.8. The correlation (r) was .64.

(3) Retests were given to 27 of the incoming group: (a) The Stanford-Binet results showed a rise from 122.1 to 128.1 mean I.Q. The correlation (r) between first test and retest was .80. (b) The Merrill-Palmer results showed a rise from 116.9 to 134.5 mean I.Q. The correlation (r) was .58.

(4) Stanford-Binet retests given approximately a year later to 29 children whose first test was given after six months or more of nursery school showed a correlation of .94 between first test and retest.

CONCLUSIONS

1. The new Stanford-Binet is highly stable and reliable for a preschool test. Even over a period of change, such as entry into nursery school, it shows a high correlation on retests (.80) and when this factor of changing status is eliminated by giving the first test <u>after</u> nursery school experience, the correlation rises to .94, which compares favorably with reliabilities in school-

age children.

2. The Stanford-Binet appears to be less affected by nursery school than the Merrill-Palmer and to be affected in a more uniform manner.

EVALUATION OF STANFORD-BINET AS A PRESCHOOL TEST

An evaluation of the new Stanford-Binet as a preschool test must be made in terms of its actual use with young children. The statistical results obtained in this study show that the new Stanford-Binet tends to have a rather higher correlation with itself on retests in this situation than has been found for most preschool tests (particularly the Merrill-Palmer and Kuhlmann-Binet). This work, however, must be done with larger numbers of children and in more diversified groups than the one here studied. Terman, Wellman, Bridges, Nelson and others have indicated that the test situation with preschool children is quite different from that with older children. Personality factors such as shyness, resistance, are quite open and likely to interfere with the successful administration of the test. Although these facts are true of all preschool age children, in our experience at the Harriet Johnson Nursery School we have found resistance and shyness to be far less characteristic of the nursery school than of the non-nursery school child, regardless of age. The school situation itself tends to produce rapport between examiner and child before the examination begins. Freedom, a feeling of security in the school situation and an increasing sense of the friendliness and trustworthiness of adults recognized as belonging to the school make the test situation relatively easy for child and examiner. The nursery school is the most favorable situation for the study of any preschool test and, for this very reason, the test needs to be studied outside of the school. It is for its general applicability, rather than for any restricted use that a preschool test must be judged.

In an article in which she discusses the hazards of preschool testing, Bridges concludes that preschool tests are too much affected by emotional factors to be of much value. Other writers (Wellman, Terman, Levy and Tulchin) have noted the very general tendency of preschool children to be shy, resistant, or uninterested in the test situation, without coming to Bridges' conclusion. Wellman's findings as to the sharp rise in I.Q. consequent to nursery school attendance may well have as much bearing upon personality and emotional development as upon general intelligence. Extension of the areas in which a child is at ease - familiarity with people outside of the family, familiarity with and ability to handle material - may certainly have a great influence on his behavior in any given situation. In spite of this, however, our experience with psychological tests in the Harriet Johnson Nursery School would cause us to agree with Bridges that these personality factors are operating in many cases to cause doubtful results, which are in turn reflected in the generally low reliabilities and correlations found in preschool tests. The test situation at these levels seems not to be measuring general intelligence so much as a combination of general intelligence, social ease, security in a strange situation, resistance to direction, and interest or lack of interest. This constellation of factors certainly means that we cannot accept test scores naïvely as a picture of what a child's ability is at any given time.

Another angle which should not be overlooked is that this very openness of the preschool child's emotional reactions may make it possible to use the test situation in a way which may be of more value in an individual case than can be derived from a simple numerical score. Since our orientation, and that of most nursery schools, has always been along the lines of individual development rather than group trends, the occasionally dubious value of an I.Q. in the preschool years need not disturb us if we use the test situation wisely. In the Harriet

Johnson Nursery School we use the psychological test results along with and against a background of the child's entire behavior.[2] Without this larger picture the results of a single test are meaningless.

The problems with which we have been chiefly concerned, as a group, are much more those difficulties of the child which affect his social relationships or his emotional stability than the prognostication of his future mental development. The need for the psychological examination as a means of differentiating subnormal from normal children is rare in a highly selected group such as ours. Instead of routine testing of all of the children, we have made the psychological staff and laboratory available to the teachers at any time. The result is that each year there are children who are puzzling to their teacher because of their behavior in the group, whom the teachers refer for psychological examination.

Does the infantile or aggressive behavior of a certain child perhaps indicate that he is too immature for his group, or does it mean that he has deeper-seated personality difficulties that find their way to expression at school? Does the impatient burst of tears when his blocks fail to behave as he wants them to, mean that his eye-hand coordination is actually poor, or his standards too high, perhaps because someone builds for him at home?

In so far as the psychological examination can shed light upon the problems arising out of an individual's life in the group we find it a useful tool in the nursery school. We find the results most illuminating as giving insight into a child's work-patterns, attitudes in a new situation, relation to materials, indeed - his total personality. The fact that he is responding to the same stimuli as other children gives the experienced examiner an excellent opportunity for judging those responses which are of a necessarily unstandardized nature. Therefore, in considering any scale of tests for use in the nursery school, we are interested in the type of information that it gives us about the child in the test situation, as well as the score. Naturally this does not mean that we overlook such important qualifications of a test as adequate standardization, or reliability. It does mean, however, that we are not ready to judge any test for use in the nursery school on a statistical basis alone.

The fact that the new Stanford-Binet covers all levels from the early preschool years to adulthood is a point in its favor. We are justified in expecting a single series of tests to throw more light not only upon intelligence but upon personality over a period of time, than if we have to change the scale itself as the child grows older. If the reliability of a test has been found to be high, a change in I.Q. from 100 at three to 120 at six may mean that the child is making fuller use of his abilities, that he is less shy or less resistant. But if a child has an I.Q. of 100 on the Merrill-Palmer at three, and 120 on the Stanford-Binet at six, we have no final way of knowing if we are obtaining a measure of different abilities, or whether the child himself has developed in his capacity to meet the test situation. Even when the mathematical relationship between two tests has been established, unless it is close to perfect, it is of little assistance in ascertaining the reasons for the varying scores obtained by a single individual.

In order to obtain a truly representative score from the preschool child, we must rely upon the skill of the examiner and the intrinsic appeal of the test material.

The material of the new Stanford-Binet is unquestionably interesting to young children. The many varieties of tests, performance and verbal, the ingenious use of material in such tests as likenesses and differences, completions, memory for objects, and others, have been found in this group to be very successful in arousing the interest and effort of the young child.

The fact that failure on many of these tests is not necessarily evident to

[2] B. Biber. *"A Nursery School Puts Psychology to Work." 69 Bank Street, December, 1934*

the child himself (as for instance, in Missing Parts, where many children say the other glove is missing instead of one of the fingers) makes for less resistance than on such a test as the Mare and Foal, where inability to place a piece of the puzzle may result in real feeling of frustration and consequent resistance in succeeding tests.

It is also no small accomplishment to have this preschool material diversified, interesting and at the same time, compact and portable, and easy to use.

Another important addition to the new Stanford-Binet at the preschool levels is the method of proceeding by half-yearly instead of yearly increments of mental age. This provides 12 instead of 6 tests per year, as on the old Stanford-Binet, thereby reducing the I.Q. value of each individual test item. Wellman and Terman have both discussed the greater weight of subtests at the younger ages, with possible resulting inconsistencies in I.Q. It is, of course, still true that each fraction of a month of chronological age, or each month of mental age is still heavily weighted at the younger ages on the new Stanford-Binet, but doubling the number of test items through year V tends to reduce the disparity.

The Stanford-Binet also gives an opportunity for insight into the level of the child's conceptual thinking, in a manner that performance tests alone do not do.

Excerpt - child V years, 2 months - I.Q. 137 - Stanford-Binet only. (Beth L.)

> In a survey of the test as a whole one important fact must be mentioned. This was Beth's carelessness and the poor quality of response on many of the tests which appeared easy, and her interest in and attention to the more difficult ones. For instance, she failed the Missing Parts on the VI-year level, giving the card the most cursory glance. She was apparently satisfied with her own answer that the "other glove" was missing, and of the shoes, that "the person" was missing, of the wagon, that nothing was gone. She also failed number concepts and maze tracing on the VI-year level, and I had the impression that she failed from carelessness and lack of interest.
>
> On the other hand the tests in the VII, VIII, and IX-year level were challenging to her, and she did actually much better on these than on the easier ones, passing all of the VIII-year tests, and verbal absurdities on the IX-year level - even though she had failed picture absurdities on the VII-year level. She failed the square on the V-year level, but almost scored on the IX-year "Memory for Design" test, drawing a careful and accurate rectangle.
>
> This may be related to her sophisticated and almost unchildlike poise, her persistent attempts to dominate her peers, and her curiosity about and interest in adults. Also, the fact that the more advanced tests were likely to be in "social form" such as question and answer, may have determined her responses as much as their ease or difficulty. But I did get the impression that she was measuring up to these hard questions with a certain consciousness of their difficulty. Certainly it is not alarming for a child to be challenged by difficulty - quite the contrary - but the aspect of B's response which seemed especially alarming was the almost <u>sloppy</u> treatment of problems that were not difficult, her boredom, her restlessness, <u>and</u> her failures.
>
> If this is true of Beth's entire response to her environment, what tremendous tension must be generated by such a precocious attitude!

On the other hand, there are several ways in which the new Stanford-Binet may be considered questionable for widespread use with little children. First, is the omission of any technique for scoring refusals at the preschool levels. Since refusals are so frequent in the preschool years it would seem to be the

better part of valor to prepare for them. Stutsman's scoring system in the Merrill-Palmer is a real contribution to the technique of testing young children. Often, in the case of non-nursery school children, in actual work in the field, one has only one session with a child, and if a test is to be practicable, it must permit a certain number of refusals without invalidating the final score. The cases where a child is brought to laboratory or clinic are, furthermore, the very ones in which one most frequently finds determined opposition. We have made use of the alternate tests in such cases, although Terman nowhere explicitly permits such a procedure. In the directions, he states "At the preschool level an alternative test may be substituted (when a test has been spoiled in the giving)." In the years above V there are no alternates, even though it is necessary to take many of the above-average preschool children into those levels. In such cases it is possible to compute mental age on the basis of 5 tests, when there is a refusal, although we have not done this in any of the cases used in this study. If this problem could be clarified by the authors of the test it would make for a more uniform procedure, as occasional refusals are inevitable in these years.

Another characteristic of the new Stanford-Binet which makes it slightly difficult to use, is a tendency occasionally to double basal or maximal years, even in the preschool years, so that a year of complete success or failure does not mean the same thing that it did on the previous revision. The tendency is one that must be taken into account and the procedure accommodated to it, probably by administering an additional series of tests at each end of the scale. We cannot at this time present any figures on this problem, as we were not aware of it until after the study was begun.

A further feature of the new test is the decided change in character of the test as the age-level increases. Beginning with year VIII, which is entirely verbal in nature, the test becomes very heavily weighted on the verbal side. Long-term studies of individuals will be necessary to determine what effect this shift in content will have upon the reliability of the scale as the child advances beyond the levels in which more items of a performance nature are included. One of the most serious drawbacks, incidentally, is the nature of this verbal content. Young children who go through many of the older levels in the course of an examination are exposed to unnecessarily lurid content in many of the items which deal with shooting, graveyards, hanging, and the like. The examiner may well weigh the advantages of a complete score as opposed to the possibility of awakening anxiety in an unstable or apprehensive child. This would perhaps be a more serious problem in clinics where cases are referred because of personality difficulties than in a group of normal children, yet it must be considered in any group.

As the test takes on a more verbal nature, it becomes increasingly dependent upon the social ease of the subject, as he remains in an almost constant relation with the examiner. Again this is more of a problem for the preschool child than for the school-age child, but it must be considered as many preschool children must be taken through these levels. We have tried to lessen the child's awareness of the examiner by the use of performance material introduced when the child shows signs of increasing shyness or fatigue. Material from the Pintner-Paterson or the Merrill-Palmer scale, or toys not part of the Stanford-Binet equipment may be used to advantage to break up the examination and to give the child an opportunity for diversion and rest. If this performance material is used according to standardized procedures it may be scored and used as supplementary, and may afford additional information to the examiner. The following report is illustrative of this:

> Carolyn G. was an extremely interesting child to test, because of the wide range and somewhat erratic character of her abilities. My impression, which I have substantiated by instances from the examination,

was that she was unusually gifted along certain lines, but with very definite "gaps" in her abilities. Perhaps these gaps are evidences of disturbance or insecurity as much as of actual lack of ability, since there were various items of behavior which seemed to me to be symptomatic of such disturbance.

At a chronological age of 4 years 3 months, Carolyn G. scored on certain of the tests in a way that was simply uncanny. Her meticulous and almost loving placement of pieces in the formboards was indicative of sure and sensitive form discrimination. In the Manikin, which involves putting together a little conventionalized figure of a man, she achieved a perfect score, - which on the Pintner-Paterson scale of tests is rated as an eight-year accomplishment. The Decroly Matching Game, a kind of picture lotto, brought out this same deftness and sureness with materials. Carolyn G. did it quickly and accurately, but with no apparent sense of hurry. Other items which she passed well above her own level on the Merrill-Palmer were the Sequin board, the Mare and Foal, the Little Pink Tower.

In rather startling contrast to these outstanding performances she failed completely the drawing of a cross, which according to the Merrill-Palmer standardization is well below her own age-level. Naturally one cannot pass <u>all</u> of the test items, so that the only reason that this is startling is that Carolyn's other performances would lead one to expect a different quality of work in this particular thing. But the interesting fact is that although she was amazingly capable in <u>matching</u> forms, showing that her actual perception of form is good, she was rather poorer than average in <u>imitating</u> it. She failed several tests which involve imitation that lie near or within her range, i.e., the six-cube pyramid - the cross - the square - the bead chain. Immediately after failing the six-cube pyramid, she took the blocks and built a charming little structure far more complicated than the rather simple one she had been asked to reproduce. Is this apparent lack of ability related to difficulty in analyzing a problem, or is it in its mild way, a resistance to set rules?

On the Stanford-Binet, the picture was much the same as on the Merrill-Palmer, - that of a child who is extremely capable in some respects, but whose ability is not consistent with itself. On the seven-year-level, in this test, she passed the likenesses ('How are wood and coal alike' etc.) which shows at least, a good grasp of informational material and relationships, - and then on the four-year-level she failed the memory for objects, which is a simple little game involving remembering which of three toys the examiner has hidden under a box. In this test she showed a tendency to perseveration, which is a rather youthful manifestation, - i.e., she answered "cat" when I had covered the doll because the previous time the cat had been on the table.

Carolyn was cooperative and appeared fairly well at ease most of the time, but there were certain manifestations that made me feel that she needs watching for evidences of insecurity and lack of confidence.

The first of these was a general tendency to retire into herself and whisper in the question and answer tests, especially if there seemed to be some doubt in her mind as to whether or not she was right.

Another item, which <u>may</u> have been the merest coincidence, but which may also be a danger signal, is the fact that she tended to do a poorer quality of work on the successive stages of the same test. This sounds more complicated than it is, but an example will serve to clarify it.

On the buttoning test, for instance, in the Merrill-Palmer scale,

Carolyn did the one-button strip in absolutely record time - about 4 seconds. The two-button strip took 14 seconds, which is also very speedy. Then on the four-button strip, where the problem is still the same, but complicated by more buttons, she failed well below the three and a half year limit, after having done the other on the five-year-level. She took 90 seconds on this last one, and seemed awkward and slow in contrast to her earlier dexterity. The same thing happened with the puzzles, although here the factor of difficulty is somewhat less calculable. The first two puzzles she did immediately and accurately, - the third she failed completely after working over it for a long time. It seemed to me that Carolyn's failure in these instances was out of proportion to the increased difficulty presented by the tests themselves. Insofar as the test situation is a "microcosm" in which the factors of personality operate much as they would in the larger world, this unevenness may indicate a more general instability. It should be checked by observation of her behavior in the group.

Another feature of Carolyn's behavior which is deserving of especial mention was her exaggerated and careful putting away of all of the equipment. Not only would she arrange each successive game in its box, but she would insist on having all of the edges even and regular. It seemed that she was under some compulsion to be extremely neat and orderly. After the test, CL remarked that she was having difficulty with Carolyn in getting her to put away at school, and I was amazed, because it had seemed so genuine a drive of hers to be tidy. I wondered if much pressure had been used at home on this problem. If so, it might be a very healthy development for her to rebel against such exaggerated care for materials, and certainly I should think that very little if any pressure should be put upon her at school to make her conform in this particular phase of school routine.

On both tests there was a very wide "scatter," which according to some psychological literature indicates that there is a tendency to instability, although this is by no means conclusive.

Her actual scores were high - the Stanford-Binet score was an I.Q. of 125, and the Merrill-Palmer sigma score was plus 1.5, and the percentile rank was 95.

Carolyn is a genuinely gifted young person who is none too sure of herself. The chances are that she will not be a "problem" in the traditional, overt, sense of the term, but she will bear watching for signs of insecurity in school and at home.

We have sometimes given the complete Merrill-Palmer scale by alternating verbal and performance tests, and obtaining a final score for both tests in this way. This may seem like undue liberty, but a preschool test is seldom administered in the same stereotyped way as a school-age test, so that it does not represent as much of a deviation from the prescribed formula as might be supposed, and it may give valuable insight.

Excerpt from Psychological Examination of Safford M. - a new child - age 48 months:

Safford made a very ready social contact with me and seemed thoroughly at ease throughout the examination. His appealing, little-child, almost Christopher Robin look and manner was in a way an index to his entire approach. He was social and verbal rather than matter-of-factly interested in the materials as so many of the nursery school children are. The wide divergence in the scores shows this up in sharp relief - an I.Q. of 131, which is definitely superior, in the Stanford-Binet

contrasted with the just average sigma score on the Merrill-Palmer. (The equivalent I.Q. would be just above 100).

Undoubtedly, this child's experience has been heavily weighted along verbal lines and one must keep this in mind in evaluating the results. It is quite probable that nursery school experience, with its emphasis upon work with materials, will tend to lessen the discrepancy between Safford's ability in performance and language tests. It will be interesting to retest him in the spring to see if the effects of his school experiences will show up in his scores.

...

His successes and failures were consistent throughout, the contrast between verbal and performance level of ability appearing on both scales.

On the other hand, Safford seemed perfectly equal to the situation and thoroughly interested. His difficulties would seem to be the rather simple results of lack of experience rather than any complicated emotional ones that would keep him from doing his best work or even from trying.

Our conclusion was that in many cases where there is some doubt as to the advisability of using the Stanford-Binet, as for instance with a very anxious child to whom answering a question is an ordeal, or with a child apparently capable but retarded in language, the Merrill-Palmer test is very valuable. Where time is not limited, we prefer to give the Merrill-Palmer along with the Stanford-Binet in all cases, in order to have a fuller picture of the individual.

Where time is limited, however, and the test-score is important, it is our conclusion that the Stanford-Binet is indicated.

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THE REACTION OF PARENTS TO READING FAILURE

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While a broad study was being made by the writer on the subject, "Maladjustments Arising in Normal Children from Inability to Learn to Read by Modern Educational Methods,"[2] the striking part played by the reactions of the parents toward the reading failures prompted the decision to treat this topic as a separate paper.

One hundred children possessing an average English vocabulary, normal intelligence (from 90 to 140 I.Q.) and no noticeable physical defects that would lead to maladjustments were chosen from the reading failures in grades two to ten in the San Francisco and Oakland schools, both systems giving hearty cooperation. Sixty-seven controls with similar qualifications were chosen from good readers in the same schools.

Parents were interviewed in the homes and each child was given an hour's interview alone at school. Sex distribution showed 72 boys and 28 girls who were reading failures, with 48 per cent boys and 52 per cent girls in the control reading group. The economic status of the families to which the children belonged were roughly classified in per cents as 11 excellent, 38 good, 40 fair and 11 poor, giving a fairly representative cross section of the population. There was little correlation between economic status and home atmosphere as judged from the viewpoint of fitness for the upbringing of children. For example, of the 18 homes found to have an atmosphere unfit for the upbringing of children, 2 were of excellent economic status, 6 of good, 8 of fair and only 2 of poor economic standing. Looking at this same unfit group from the viewpoint of intelligence, the parents of five had intelligence and education far above average, 5 were of good intelligence, 6 of fair and 2 were ignorant (not the same 2 that had poor economic standing). Evidently neither wealth, intelligence nor education, singly or together, presupposes an atmosphere fit for the upbringing of children.

In general, failure in arithmetic has long been accepted in a matter-of-fact way, with the excuse that the child has "no head for figures", often adding that the child "takes after" the mother. No such attitude was found toward reading failure in the parents interviewed. The child that cannot read is one set apart, abnormal, queer, not quite right. To get mixed on fractions and decimals is understandable but to be unable to read - that is beyond the pale. It is past their comprehension that a child of normal intelligence cannot learn to read - there must be something wrong with him, he is backward or perhaps subnormal. Even in cases where the school is blamed, there is always a doubt in the mind of parents and relatives that the child is quite right, because all about are siblings, classmates, neighbors, cousins or other relatives that have learned to read even if they didn't seem so smart before they went to school. As a rule the parents were puzzled, confused and at their wits end while discussing the question, though there were some parents found who showed little interest in their children's schooling, 10 per cent of the mothers and 32 per cent of the fathers (mostly of younger children; fathers seem to get closer to their children later on).

The attitude of 66 per cent of the mothers and 28 per cent of the fathers was expressed by the person giving the history as worried, anxious, distressed, upset, greatly concerned, troubled, bothered or disturbed over the reading situation. Such attitudes are surely not conducive to a feeling of security on the

[1] *From Stanford Medical School.*

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CHILD DEVELOPMENT, Vol. 10, No. 3 (September, 1939)

part of the children. Baffled, shocked, desperate, despairing, hurt, discouraged and disheartened expressed the state of mind of 10 per cent of mothers and 11 per cent of the fathers and most assuredly would not lead to peace of mind in their children. Still worse to live with were the furious, annoyed, sarcastic, impatient, provoked and angered parents, 21 per cent on the paternal and 10 per cent on the maternal side. What shred of security would be left in the child of severe, disgraced, resentful, chagrined, disgusted and mortified parents, 4 per cent of mothers and 9 per cent of fathers? These emotional reactions seemingly overrode intelligence, social standing or economic security - the impeccable banker was no more deeply angered than the shabby WPA house painter.

Case 66. Mother stated her superior-looking girl was merely being wilful in not reading, she "doesn't care", "could read if she wanted to", "is too lazy", "shows no interest", the proof being that she refused to read even when offered horseback lessons. Mother is "very much provoked" over this disgraceful state of affairs, and in a desperate effort last year made her study daily after school becoming very cross when helping her. This, coupled with the teacher's impatience and complaint of inattentiveness to the work the child could not accomplish, sent the girl to bed at the close of the term for five weeks with a nervous disease very difficult to cure. Now the mother is irritated because this girl is becoming "nonchalant" and "tight-lipped" after four years of failure, and prides herself on being strict with her and "not letting her get away with it."

It would be bad enough to live with any of these attitudes just once in a while but the subject of school and homework occurs five days a week, month after month and year after year to say nothing of Sundays when relatives turn up to visit and as one nettled mother exclaimed, "My sister-in-law drives me wild the way she always brings up the subject of reading as if by accident, brags on how her children read, and then asks how poor Alice is doing." Most of these attitudes become chronic and as a small boy of ten put it, with face working and eyes full, "Dad used to be pals with me a lot but he's mad now about reading and don't take me out with him hardly no more."

To have no siblings that could read was the good luck of 39 of the children, but 61 were unfortunate enough to have one or more siblings (up to seven) that read well, 4 of these siblings in different families being feebleminded but reading easily and well. Of the 39 without reading siblings, 23 were "only" children, (27 per cent of the controls were "only" children also), the siblings of 4 were too young to read and the siblings of 12 could not read either. Not that lack of reading siblings saved odious comparisons, since 53 children had rival cousins, 12 had other relatives and 55 had playmates in the neighborhood that read well and with whom belittling comparisons were made. But without the presence of a constant reminder in the home, the nagging, prodding, scolding, punishing and ridiculing proved not likely to reach the harassing heights so often found in the other homes.

Case 56. As the mother worded it, she had a problem with the father, an attorney, who on discovering the child could not read was overheard by the child to explode, "That boy is plain dumb and never will learn." Then when on top of this, little brother and cousin learned to read fluently, the child refused even to pick up a book or try to do any reading whatever in the home during the next five years. Putting him into the subnormal class at school did not help matters either.

It was evidently beyond human endurance for 87 per cent of parents to refrain from disagreeable or cutting comparisons with successful rivals, "Now, why can't you read like Helen?" "What's the matter with you that you let Johnny get ahead of you like that?" "Aren't you ashamed, a big boy like you, to let your little sister beat you in reading?", often after a demonstration of the supe-

riority. All of this going on and on and on, continuing for months and years on end - up to nine years on this series - with intensification of existing unpleasant emotional states. In 15 families irritated parents or step-parents allowed jealous older siblings to jeer and bully these reading failures outrageously.

The next commonest effect, 86 per cent, was for the parents to reproach the child for not having worked harder saying he would have learned to read if only he had done so, the implication being that it was the child's own fault entirely. From observation, the majority of these children were perfectly helpless in knowing how to attack the problem of recognizing a word, beyond staring at it intently, much as adults would gaze at a strange Russian word. Evidently the ability of these pupils to store visual images of words and correlate them with the spoken word was weaker than in their successful rivals, and no other method of approach could be detected as having been taught. This putting the blame on the child did much to destroy his self-confidence, always lost as the years rolled on.

Flinging derogatory terms at the victims seemed to act as an outlet for the parents' seething emotions in 76 per cent of cases. The mildest taunt used and the one first applied was lazy (67 per cent), stupid came next (40 per cent), then dumb (49 per cent) with a scattering of "boob", dunce, "simp", "bonehead", "big sissy", blockhead, fool, idiot and feebleminded. Blighting comments were not uncommon.

Case 37. A bright-faced little girl, rejected by her mother for the brother but devoted to her father whose pet she used to be, was scorned and flouted by both as they called her lazy, stupid, dumb, indifferent and too satisfied with herself. The mother reported that the father was very irritable and annoyed and relatives looked down on her as "peculiar" on account of her inability to read. When asked how her mother felt about her reading, the child replied, "Mother always says, 'I'm not going to worry about you and your reading'"; while father said, "When I was little I would have been strapped if I couldn't read; I'd strap you hard if I dared." "Mother gives lickings and father hollers about it" - this treatment from parents who do not like to read and say they do very little of it.

Despairing parents, when the school failed in the task it set out to accomplish, took on the job and tried to save their pride. To those that failed in their teaching the results were disastrous but it was an interesting surprise to find that only 30 per cent of the good readers assigned by the schools as controls were taught by the current educational method in vogue at this time, that popularly termed the "look-say" method. Twelve per cent of the good readers were taught to read by their parents before starting to school, all by the old-fashioned phonetic method by which these parents themselves had been taught. Fifty-one per cent of the controls were taught "phonics" at home by the parents concurrently with the modern "look-say" method at school. In seven per cent the method was not determined. Thus 63 per cent, at least, of the good readers were taught phonetics, learned to read and were saved much suffering. Parents of 8 children picked out by the school as good readers did not consider their reading satisfactory according to the family standard.

Evidently the parents of the reading failures were not good teachers and apparently did more damage than good by their efforts. So-called help was given to 85 per cent of the children and of those attempting to give help 91 per cent became impatient, "terribly impatient", "hollered", "yelled", "got mad", cross, "turrible" mad and "awful" mad when after teaching a word for about the fortieth to the hundredth time it was still unrecognized when next encountered. Some were made to study reading even in the noon hour.

Case 26. (Three years' failure). Mother was "annoyed beyond words" and the father was "extremely irritable" because the boy would not read. He has been

made to study both after school and in the evenings at which times the parents' "tempers flare up" and they "go to pieces" while the boy "fidgets, twists, picks, scratches, gnaws his knuckles, chews his clothes, jerks his head and drives everyone nearly crazy, including himself." It ends up with his being fussed at, scolded hard, having his 'bike' locked up, deprived of shows or spanked to relieve the surcharged atmosphere. Three years of this and he still cannot read a single sentence and is now regressing to baby talk.

Case 61. After five years' failure he still is forced to work on his reading for a half-hour after school and a half-hour in the evening. "I sure get heck." "Mother doesn't get impatient, she gets mad and makes me feel not so good, not so hot." Then he has to stay in the house, can't go to shows, can't ride his bike nor listen to his favorite radio programs. After five years he says it's no use.

The amount of scolding done not counting nagging and prodding would be voluminous if recorded, since 70 per cent of parents indugled freely, from the primary grades up through high school, with incalculable effect on the child's developing personality. In justice to these intelligent children it is only fair to state here that the conclusion has been reached after two years' study of this problem that these pupils have been perfectly helpless in attacking the problem since the modern educational method by which their successful rivals learned to read has omitted the type of learning process by which their minds could and would grasp the meaning of reading symbols if given the chance. This fact was proven in a previous study - "The School Looks at the Non-reader" - in which 77 per cent of the reading failures were taught to read satisfactorily and 13 per cent with fair success (10 per cent left the City) when taught by skillful teachers who employed any and every method of teaching reading that proved effective in given cases and not just the one method in vogue at the time.

Case 74. Neither mother nor father, a professional man, could understand why their child could not read. Many, many rankling comparisons have been made and much too frequently, said the mother. Both the parents have tried to teach him daily and have become very much irritated in the process. The father, a "reserved and highly-strung" man is "greatly disappointed and chagrined" and at times when he has reached the scolding stage, has "blurted out" that the boy was dumb, stupid or lazy and must be a fool not to be able to get it, scoring him roundly and stopping his allowance as punishment - this from a father that is worshipped by his adolescent son. The mother, herself, was shocked to hear the boy glibly tell outsiders that he had read this or that interesting fact, which in reality was an impossibility and he was merely "saving his face" (after seven years of failure).

Depriving of privileges whether as an incentive or retaliatory measure was admitted by one-third of the parents and took the form of being sent to bed, not being allowed to play, go on trips, to shows or the circus, bicycles locked up, radios removed, allowances stopped or in one case of six years' failure deprivation of athletic sports at the Olympic Club.

Ridicule and mockery were also used in 55 per cent of homes as weapons presumably to reduce the child to the desired state of mind. (Ridicule by teachers and others outside of the home is not included here).

Case 13 has learned to put on a wooden expression when his reading is "made fun of by mother, father, nurse and even the cook when he's mad."

Case 35 stutters "a lot when father makes fun over my reading and he gets mad and yells for me to stop stuttering."

Case 17. "Father makes fun of my reading all the time." "Mother gives me the dickens." "They both yell at me about it; wish I could get even." Mother and teacher have called him lazy and dumbell when mad and threaten to have him put back. The father is simply disgusted with him, reported mother. All say

he's to blame for not working harder and so take away his radio, trips and shows. At first, with the face of an angel, he announced sweetly that he read "fine," but on being asked to do so, confessed he just pretended he could, told everyone that he didn't care and made believe he was sick lots of times to stay away from school so he wouldn't have to try to read. Nails bitten to the quick.

Physical punishment as a reading remedy was dealt out to these unfortunates in one-third of the homes. No.40 was strapped on the seat and legs. No. 14, a dainty, timid little girl of 9 from a beautiful home received strappings or hair-brush spankings from her father, a college graduate and manager of a large commercial concern. "It makes mother and I feel awful." "He gets awful mad when he tries to teach me to read, and I don't feel nice about it and I begin to stutter and then he gets madder than ever." No. 62 used "to get hit with a horsehide strap when 8 or 9; that's the year I blinked my eyes and stuttered."

Case 7. Sister, numerous cousins and playmates were all successful readers. The parents' pride was outraged that persons of their social and professional prominence should have a "dumb" child that everyone was talking about and that the relatives looked at in a questioning way as if he were subnormal. By the third year of failure the mother added to her scolding and nagging by striking him across the face when her patience gave out in trying to make him read, called him stupid, "dumbbell", you little fool, took away his privileges, treats, rides, recreation, trips, etc. and treated him as an outcast. The father called him silly, big boob, dumb, fool and idiot, raged and stormed and when he failed on the same word for the nth time, took to striking him with his leather belt. Expensive games, toys, puzzles, etc. were handed him, "Read those directions and you can have them"; then when he couldn't they were taken away with scathing denunciation. The boy now has a bewildered, cowed look.

On being asked the cause for failure, 30 per cent of the parents said it was due to a poor start, 16 per cent blamed the school, one laid it to mental deficiency (I.Q. 112), one complained there was no need to read with radios around and 52 per cent laid the blame entirely in the child (will not concentrate, won't try, too lazy, won't work). The poor start mentioned was explained as promotion with no knowledge of reading after absences of from 2 months to 9 months in the first grade and no subsequent coaching to make up the lost reading foundation. With a majority of parents having their attention focused on the child as a culprit for the misdemeanor of non-reading it is more understandable why 44 per cent of the parents had noticed no first effects of the failure on the children themselves. When the question was asked, most of them looked so surprised that it was apparent that it had never dawned on them to look at it from the child's point of view. Some of the more intelligent were nonplussed when confronted with the possibility that the child's personality might be affected, searched about quickly in their minds and finally connected given attitudes and behavior as being explained in that way. Of course, others had grasped the situation from the first.

Case 38. An outstanding-looking boy. The entire family thinks the child is backward mentally (I.Q. 111). Mother talked two-thirds of the time about a sickly older brother on whom she dotes, who reads well and is allowed to tease and torment the non-reader like a typical bully. Pretty twin sister also reads well, a fact thrown up to the child all the time at home and school. The mother recollected that when these comparisons began he became very unhappy, then fussed about going to school, complained of headaches to stay home and later said it was no use, that the teacher didn't like him the way she did sister and said she wouldn't promote him. Whenever twin sister and bullying brother brought home school slips about their accomplishments, the badgered little fellow would "become very naughty, would answer back, refuse to do things he was asked to do, be cross and very irritable and would fight with any child at the drop of the

hat," all probably as a protest against what appeared to be unfair discrimination to him. When the mother finally connected the slips with the misbehavior and had the school stop sending them, these "spells" ceased. Lately the mother has heard him tell outside children that he is further advanced than he is in order to avoid the intolerable pity and derision given inferiors.

When the treatment meted out to these culprits is reviewed, the acid comparisons, scornful epithets, jeers, taunts and punishments, or even the never-ending nagging, scolding and prodding, one wonders what else these unfortunates could do to cover up the hurt at the time, except to put on a "mask", a "wooden expression", look "stony-faced", "nonchalant" or indifferent as complained of as being the first effects of failure by 19 per cent of the parents. This attitude was common in the smaller children when the recriminations began, and from being misunderstood by the parents, no doubt led to increased irritation and pressure on the children. Later on, with the continuation of the treatment depicted, the number reported by their parents as showing an attitude of indifference increased from the 19 per cent mentioned to 50 per cent, which may account for some of the rancor shown and the severity of treatment to break down the indifference.

But what does it show about the insight of the parents? When the children were asked by the interviewer how they read, 20 per cent (mostly 8, 9, and 10 year-olds) said, "fine", "O.K.", "good", etc., but on being asked to demonstrate their ability, promptly capitulated, saying they just pretended they could read so nobody would know, an attitude indicating oversensitiveness rather than indifference. When the subject was discussed non-critically and with sympathy, 79 per cent of all the children said they tried not to let anyone know they couldn't read, and 92 per cent said they just pretended they didn't care, and then went on to tell how worried, ashamed and discouraged they were. The conclusion seems inevitable that at least 50 per cent of the parents did not show a good understanding of child nature in this matter, perhaps through ignorance, perhaps through prejudice because family pride had been cut, but in all cases to the detriment of the developing personality of the child.

Asking for the causes of failure, of course brought forth a shower of complaints, only one of which will be taken up here, the grade of S, and that because the exasperation of the parent on finding the child's reading graded on the report card as S (satisfactory) when he could not read a sentence, found an outlet, perhaps subconscious, in increased irritation toward the child as the subject of reading became still more obnoxious. The first parental reaction to the grade of S for poor work seemed to be a hurt one, that their faith in the school had been betrayed. With continuance of the S, this attitude was succeeded by a deep resentment at the schools' attempts to "dupe", "trick", "make a fool of" the parents so the "schools could cover up the amount of poor teaching they were doing." Some took it as "an insult to the parents' intelligence to have such a lie sent home." Nor was the tension relieved, but rather intensified, by the explanation of the school that S means satisfactory for the child's mentality and stage of development as judged by the teacher. "It's too easy for her to mark S and hide her poor teaching." (Note: this will be considered further in another article).

In conclusion, parental reactions expressed intolerance toward reading failure. The parents described their attitudes in terms of anxiety, despair, annoyance, anger, disgust, mortification and desperation and placed the blame on the child in the majority of cases. What can be concluded but that mere children can hardly be expected to make the successful adjustments so essential to a happy home under attitudes such as are listed, and that maladjustments are bound to occur in these normal children? Placing the blame on the child is rank injustice and is either felt as such by the victims, with the usual reaction of mankind against injustice, or if the burden of guilt is accepted by the child

his personality tends to be overwhelmed by guilt feelings with disintegrating effect, as time passes on.

Since these distressing attitudes of the parents are followed by blighting comparisons, derogatory terms, reproach, ridicule, deprivation of privileges and physical punishment used as emotional outlets as well as punitive measures by the adult superior parents, will it not have to be concluded also, that the maladjustments of the immature inferior children will increase in number and intensity as days, weeks, months and years prolong the agony? Nor can repercussions be ignored that arise from the parents' failure to teach beginning reading - itself a highly skilled process calling both for intensive training and experience if all types of normal minds are to be taught successfully. Neither does this reading situation foster the home-school rapport and cooperation hailed as most desirable in educational conferences. Here it has been found to lower the opinion of the school in the eyes of the parents and has aroused unhealthful antagonism toward the school system.

Does not this unwholesome reading situation cry out for specific help for our present failures beyond the dab of remedial reading condescendingly tossed to them by the annoyed school officials and put in the charge of any teacher whatever who has some spare time? The teaching of beginning reading should be recognized as the work of a specialist who has all the skills and arts of many methods of solving a problem, not just the 'get-rich-quick' method that has been in vogue in reading. Who can blame the parents for trying the best they know how to take on the work of the school after it failed, when they envisioned the fate of a readingless adult in this highly competitive world? But the parents have failed as a whole, with disastrous effects on their own dispositions, the peace of the home and the developing personality of the child.

Is it not time to call in experts, not amateurs, to treat this appalling condition, and, equally important, should not the experts be called in as soon as any signs of the disease appear without waiting for it to fasten its toils on the whole school life of the victims leaving them crippled and scarred for life? Neglected tuberculosis is no worse in the physical field than neglected non-reading in the mental field; preventive work is equally important in both. Would it be too presumptuous to suggest that only specialists in teaching beginning reading be assigned to the grade or grades in which that subject is taught, rather than the teacher without specific training and experience under supervision - the general practitioner in the teaching field, so to speak?

THE RELATION BETWEEN CHANGE IN BASAL METABOLISM AND GROWTH DURING ADOLESCENCE

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A. STATEMENT OF PROBLEM

The problem of basal metabolism[4] - as measured by the consumption of oxygen or heat production in the resting, fasting body - would seem to be one thing for the adult body, where growth processes are at a minimum, and another thing for children where growth processes are very active. Our query is: Can we differentiate the basal metabolic processes concerned in maintenance of the body - whether large or small, adult or developing - from those concerned in growth?

Many determinations of basal metabolism have been made upon babies and older children. Magnus-Levy and Falk, in 1899, concluded that the basal metabolism is low in infancy, high in childhood and low after the onset of old age; while it is essentially constant during adult life. Later, more refined studies, have shown that in adults heat production decreases with age[5] (Harris and Benedict, 1919, p. 125). In the case of about sixteen boys between the ages of 6 and 16 it has been found that basal metabolism is much higher than in men. The studies made up to 1919 on girls were inconclusive. Benedict and Talbot (1921, p. 133), on the basis of much more extensive studies, found that basal heat production when referred to age follows a mass curve much like that of growth, increasing rapidly during the first postnatal year and then, after two years, more slowly, gradually and smoothly increasing to age 13. When basal heat production was referred to weight (instead of age) the form of the curve was in general the same. Metabolism per unit of body mass is noticeably higher at 6 to 8 kg. of weight than at any other time of life.

The work that comes close to ours, both in method and, in part, in aim, is that of Nylin (1929). He measured the basal metabolism of many children to determine variations associated with season, sunlight and rate of growth. He used the apparatus of Krogh, of which ours is a variation. He found that in the periodic annual changes in rate of growth in school children weight increase varies inversely with height increase, and that standard metabolism for children at about the age of 6 years exhibits a periodicity closely connected with the periodicity in height increase, "in that during periods of great height increase the standard metabolism rose."

Topper and Mulier's (1932) investigation was similar to ours in that they took repeated measurements of basal metabolism on 28 girls and 10 boys, semi-annually during 1 to 4 years, at between 10 and 16 years of age, using Krogh's respirometer. They thus sought the "puberty reaction" as Göttsch (1926) called it. They found an increase of basal metabolism at various ages but centering around 12-1/2 years for the girls and 14 years for the boys. They state that the height of increased metabolism varied with the individual.

Boothby, Berkson and Dunn (1936) have (in an extensive series) found an increase of calories per square meter of surface in boys at 14 years and in girls at 9 to 11 years. These are nearly the ages when the adolescent growth spurt is occurring.

[1]From Carnegie Institution of Washington, Eugenics Record Office, Cold Spring Harbor, N. Y.

[2]From Letchworth Village.

[3]From Carnegie Institution.

[4]"The sum total of all the vital activities of the quiet organism in the absorptive condition." (Benedict and Talbot, 1921, p. 2).

[5]DuBois, 1916.

CHILD DEVELOPMENT, Vol. 10, No. 3 (September, 1939)

Recently Nakagawa (1937) has measured the basal metabolism of 10 boys and 14 girls every six months through the pubertal period. He observed, as had DuBois (1915), Topper and Mulier (1932) and others that there is an increase of basal metabolism preceding puberty; but he does not correlate this with changes in physical growth. Talbot (1936, p. 7) finds that rapidly growing adolescent girls have a higher basal metabolism than that of the average child; and (p. 57) believes that the rate of metabolism is affected by the speed of growth.

While basal metabolism has thus been measured for a large number of adults and not a few children of all ages, there have been secured few "longitudinal" series of measurements of basal metabolism on growing children correlated with their changes in rate of growth. Also some reputable investigators do not find any "pubertal reaction". The field needed further investigation.

Our problem involved determining what changes, and how much change, in basal metabolism occurs in individual children at the period of spurt of growth that precedes puberty. For this purpose a number of boys and girls whose growth was being observed regularly had their basal metabolism determined, by the method of oxygen consumption, usually on their birth month, from about 10 to 18 years of age.

Acknowledgement is gratefully made of the opportunities afforded for this study by the Department of Mental Hygiene of the State of New York; and the Carnegie Institution of Washington through its Eugenics Record Office. Miss Renfroe took the basal measurements, heights and weights. Mr. Hallock made the more complicated computations. Dr. Davenport is responsible for most of the text.

B. MATERIALS AND METHODS

The study was made on some 55 boys and 55 girls at Letchworth Village, an institution for the feebleminded. A selection was made of children of fair intelligence, free from neurological symptoms, cooperative and of suitable age. The ages between 8 and 13, mostly 10 to 12, were chosen so that the children would, within a few years, be experiencing the adolescent spurt of growth.

The children selected, with the institutional number, month and year of birth and racial stock are listed in Tables A and B for boys and girls respectively. The ages in years are given in the middle column. Metabolism tests were made yearly on all individuals in the month in which they were born and the physical measurements were made within the same month and also six months later.

The basal metabolism of this group was determined with the Sanborn Graphic apparatus which measures directly the amount of oxygen that is used by the individual. The oxygen is held in an easily movable bell. The individual breathes into and out of this bell by means of rubber tubes. The flow of air is directed by rubber flutter valves. The carbon dioxide and moisture of the breath are absorbed and thus removed by calcium and sodium hydroxide. A rubber piece fits in the mouth and then is attached to the rubber tubes. A tight clip is placed on the nose to prevent breathing there. The patient breathes oxygen in the bell which is attached by pulleys and a counter weight to a pen. As the bell rises and falls so does the pen and thus a graph is made on a revolving drum. The drum makes one complete revolution in eight minutes. The distance the bell falls multiplied by the cross sectional area of the bell will give the amount of oxygen used by the individual (Figure 1). This volume is reduced to 760 mm. Hg and 0°C.

To get the basal conditions (conditions at which the least amount of oxygen will be used and the patient awake) a routine procedure was followed.

Two boys or two girls were brought into the hospital at one in the afternoon. They were given a regular supper at 4:30 P.M. and put to bed at 6 where they

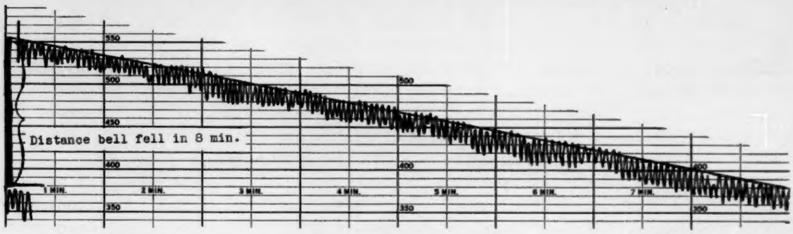

Fig. 1. Graphic records of respiratory movements and oxygen consumption of a single subject during 8 minutes.

stayed until 8:30 the following morning without breakfast. They were then taken upstairs to the room in which all tests were made and put to bed again for 1/2 hour. During this 1/2 hour the machine was tested for leaks to be sure that it was air tight. An eight minute test was run on one and then the other until two tests were done on each. If the patient was afraid or uncooperative, several short tests were made until the breathing seemed easy and natural, then the two tests were run. This was repeated the next day except that the patient remained in the hospital until all tests were completed. The amounts of oxygen thus consumed were measured.

Of the four tests on each person only one was selected as the "best test" and it is the one that is used. As it is an air tight system that connects the oxygen bell and the patient's lungs it would seem that the lowest amount of oxygen consumed would be the best. In general it is and was so chosen. Any leak in the system would occur at the nose or mouth piece as the machine was tested before each group of tests for leaks. Leaks can easily happen. Contracting the muscles of the nose may start a leak there. Chewing on and moving the mouth piece can start a small leak there. These things frequently happen, not because the patient is uncooperative but because it is quite natural for children to move or chew on something in the mouth. A leak there would probably cause more oxygen to be lost from the bell, apparently increasing the amount used. If there is only a small leak out, a regular even graph is usually obtained to all appearances good but showing an increased use of oxygen. Therefore, taking the lowest reading would tend to eliminate any such error. However, the mouth piece can be moved so that air is sucked into the system. When this happens the graph will for a while be regular and even; then the tops of the expirations will appear above the general slope for a short time, giving the graph a curved appearance (Figure 3). All such graphs were discarded. Irregularity due to holding the breath or taking deep inspirations appear different and were accepted. Other errors that cause a low amount of oxygen are a fast running clock and a calcium hydroxide which no longer absorbs carbon dioxide. However, these are frequently checked and thus eliminated. Therefore, only the graphs were chosen in which the slope was definitely and easily established. From these graphs the one which showed the lowest consumption of oxygen was chosen and used to calculate the basal metabolic rate.

The amount of oxygen an individual consumes depends on his height and weight or body surface, age and sex. Standards based on the above factors for people of normal build and physical condition have been worked out by Aub and DuBois, Benedict, Harris and Benedict, Benedict and Talbot, and others. The standards of those mentioned have been abridged, reduced to cubic centimeters of oxygen consumed per minute and published in Sanborn's booklet "Instructions with Table of Normal Consumptions and Basal Metabolic Rate," January, 1933. In Sanborn's

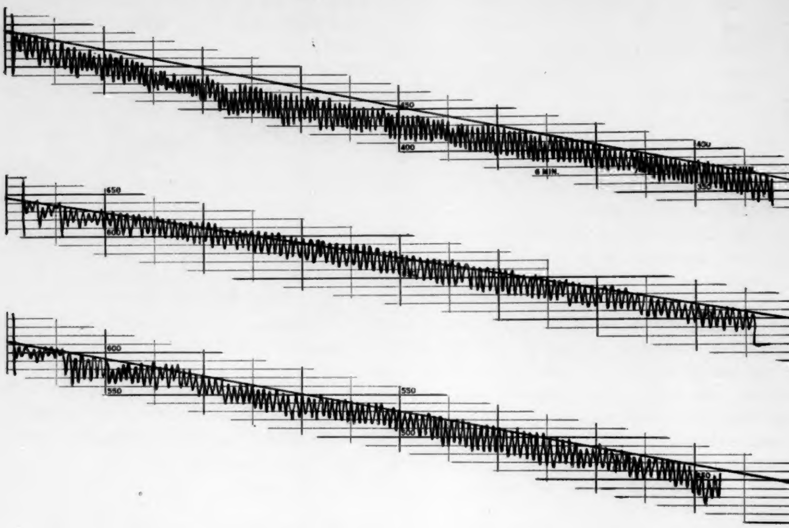

Fig. 2. Parts of graph curve downward from the general slope of the whole. This type is discarded.

Fig. 3. Parts of graph curve upward from the general slope of the whole. This type is discarded.

Fig. 4. Occasional points appear above or below general slope but do not form a curve. The rate appears constant. This type is accepted.

booklet ("Instruction", 1927) are published standards taken from Aub and DuBois and Benedict and Talbot. These are combined and referred to as Sanborn Normals here. These were the first standards used in this study. Later Benedict and Harris and Benedict standards, as above described, were applied.[6]

Each patient is weighed and measured after the morning tests. The amount of oxygen that a physically normal person of the same height and weight, age and sex would use was determined from the table of standards. This is compared with the amount the patient actually used during measurement. The per cent that the actual amount used is above or below the standard amount is sometimes called the basal metabolic rate (B.M.R.). We prefer the term "percentage deviation from standard" (abbreviation P.D.S.).[7] A 14 year old boy with a height of 145 cm. and a weight of 40 kg. is taken for an example. The standard amount of oxygen consumed for these factors, according to Aub and DuBois tables is 201 cc. of oxygen per minute. By actual measurement it was found that the boy really con-

[6] *In order to compare basal metabolism determinations obtained by oxygen consumption with the earlier determination by means of the calorimeter, it is useful to keep in mind that the "respiratory quotient" (volume of CO_2 divided by volume of O_2) is more or less arbitrarily taken as 0.82, and that the consumption of 1 liter of oxygen is equivalent to 4.825 Calories. Such is the basis of the standard conversions from calorimeter findings to O_2 consumption given in published tables.*

[7] *The percentage deviation from standard has been called "basal metabolic rate", B.M.R. (Boothby, Berkson and Dunn, 1936; Toppar and Hellebrandt, 1938). It seems unfortunate to use this term for this deviation because (1) the term has been employed as synonymous with basal metabolism (Boothby and Sandiford, 1929), and (2) it seems to us a misnomer. It is a rate of departure from a standard, not the standard rate itself.*

sumed 190 cc. of oxygen per minute. This is 11 cc. or 5 per cent less oxygen than the standard amount. Therefore, his percentage departure from standard is -5 as compared with the particular standard used.

However, there is a variation between standards. The standard amount using the Harris-Benedict tables for the same boy given above is 180 cc. of oxygen per minute. This is 10 cc. or 5 per cent above the actual amount consumed. Therefore, according to this standard, the basal metabolic rate (percentage departure) would be +5.

There is more variation among the standards for girls. Take for example a girl 14 years old with a height of 145 cm. and a weight of 40 kg. According to the Aub-DuBois standards she should consume 188 cc. of oxygen. According to Benedict normals for girls she should consume 150 cc. of oxygen. If this girl by actual measurement consumed 180 cc. of oxygen this would be 8 cc. or 4 per cent less than the Aub-DuBois standard and 30 cc. or 20 per cent above the Benedict standards which would give her a "basal metabolic rate" (percentage departure from standard) of -4 or +20 depending on the standard used.

A correlation was made between the weights of each case and the amount of oxygen consumed, using all the cases before May, 1934. The correlation was 0.857 for boys and 0.841 for girls. Since the correlations were so nearly the same the basal metabolic rates of the girls were computed using the Harris-Benedict standards for boys. This is shown in Table 1.

TABLE 1

PERCENTAGE DEVIATIONS FROM STANDARDS AS OBSERVED, GIRLS

P.D.S.	Sanborn Standards No. Cases	Sanborn Standards %	Benedict Standards No. Cases	Benedict Standards %	Harris-Benedict Standard for Boys No. Cases	Harris-Benedict Standard for Boys %
Above +15	1	0.5	24	11.5	---	---
+11 to +15	2	1.0	35	19.0	---	---
+6 to +10	9	4.0	27	14.0	2	1.0
+1 to +5	31	16.0	29	16.0	16	12.0
0±	11	5.0	15	8.0	11	9.0
-1 to -5	48	23.0	20	10.0	27	20.0
-6 to -10	48	23.0	21	10.5	38	29.0
-11 to -15	27	14.0	8	4.0	21	16.0
Below -15	29	13.5	13	7.0	18	14.0
Total	205		192		133	

The percentage deviations show a more nearly normal distribution when the Harris-Benedict Standards for boys are used. However, these standards appear about 10 per cent too high, due to sex. The Sanborn Standards appear 5 per cent too high and more scattered. The Benedict Standards based on weight and age only are too low and more scattered in distribution.

The Harris-Benedict Standards show slightly the better distribution.

There are more cases under the Sanborn Normals than under the others because those normals under 14 years of age were based on weight only and the height of the patient was not determined when the test was done. The Benedict-Standards for girls were based on weight and age, but the age limits did not go as low as those of the 13 patients here.

The Harris-Benedict Standards as given here are best for determining the deviations of this group of boys and girls.

In determining the basal metabolism of another group of 15 boys a wide variation was noted in the amount of oxygen apparently consumed by an individual on the same and successive days. The matter was brought to the attention of Dr. Benedict and he suggested that the technician come to the Carnegie Institution's Nutrition Laboratory at Boston and work for a while. Miss Renfroe went, and

TABLE 2

PERCENTAGE DEVIATIONS FROM STANDARDS AS OBSERVED, BOYS

P.D.S.	Sanborn Normals No. Cases	%	Standards Harris-Benedict No. Cases	%
Above +15	1	0.5	10	7.0
+11 to +15	6	3.0	10	7.0
+6 to +10	20	10.0	21	14.0
+1 to +5	35	17.0	33	22.0
0±	18	9.0	17	11.0
-1 to -5	43	21.0	24	16.0
-6 to -10	44	21.0	23	15.0
-11 to -15	21	10.0	8	5.0
Below -15	17	8.0	5	3.0
Total	205		151	

worked for a week using a new type of apparatus and received many instructions and suggestions as to technic. The new machine worked on the same principle as the Sanborn Graphic except that a metal helmet with an isinglass window and rubber diaphragm was used instead of the nose and mouth piece and a motor was used to circulate the oxygen instead of flutter valves. The helmet fits over the head with the head resting comfortably on a support inside and the rubber diaphragm fits tightly around the neck to prevent oxygen escaping. The motor blower keeps a fresh supply of oxygen flowing in and the patient can breathe through the nose naturally and easily.

The cross sectional area of the bell on the new machine was 207.4 sq. cm. and on the Sanborn Graphic it was 284.6 sq. cm. Therefore, a fall of 1 mm. in the bell of the new machine would be equivalent to about 20 cc. while in the other 1 mm. fall would be equivalent to about 28 cc. oxygen. This would make it easier to measure more accurately the amount of oxygen lost from the bell of small area. A small leak was made by drawing a glass tube out to a fine capillary ending the size of a pin and inserting in the apparatus so that oxygen could be lost. This leak could be detected on the new machine by placing a weight on the bell; in the Sanborn Graphic the same size opening could not be detected. (The Sanborn Company now puts out a model with a bell of smaller area).

Dr. Benedict gave us permission to take the machine to Letchworth Village to try it on the children here. A group of 15 boys was chosen. They were brought into the hospital two at a time and the same routine was followed as described above. However, they were kept longer than the usual two days of the other group. They were tested alternately on the Sanborn Graphic and the new machine until 4 tests had been made - 2 on each machine. The results are shown in Table 3.

There is less variation with the new machine. But the best tests taken from each group agreed quite well, except in the case of Clu., Ols., Robert and Mea. Clu. and Mea. disliked the helmet of the new machine but Ols. did not object. Eight preferred the mouth piece, 2 were indifferent and 5 preferred the helmet. However, 11 of them had had previous experience with the Graphic apparatus using the mouth piece. Reasons for not liking the helmet were: "too long" (tests actually took the same time), "too shut-in", "afraid", "too hot". Reason for liking the helmet was because it was easier.

After the testing of this group the machine was returned to Dr. Benedict.

It would appear from the above that any variation in the amount of oxygen consumed in the Graphic was probably due to a leak at the nose or mouth piece. To check this a brightly polished piece of cold metal was placed near the mouth

TABLE 3

COMPARISON OF FUNCTIONING OF NEW (BENEDICT) MACHINE AND THE SANBORN GRAPHIC

Name	Variation between tests New Machine	Graphic	New Machine 1	Best Test Graphic 2	Difference
Mea., George	19 cc	26 cc	206 cc	194 cc	+12
Ham., Earl	30 cc	53 cc	141 cc	144 cc	-3
Ben., John	24 cc	27 cc	171 cc	179 cc	-8
Gio., Michael	34 cc	39 cc	221 cc	228 cc	-7
Col., Frank	20 cc	22 cc	252 cc	256 cc	-4
Cap., Ralph	17 cc	40 cc	174 cc	175 cc	-1
Jon., Ivan	25 cc	26 cc	192 cc	200 cc	-8
Ben., Willard	31 cc	39 cc	226 cc	226 cc	0
Hol., Robert	32 cc	34 cc	157 cc	156 cc	+1
Wey., Frank	7 cc	19 cc	246 cc	252 cc	-6
McDo., John	16 cc	30 cc	194 cc	186 cc	+8
Ols., Robert	16 cc	21 cc	177 cc	167 cc	+10
Ols., Richard	14 cc	18 cc	163 cc	167 cc	-4
Clu., Harvey	16 cc	23 cc	182 cc	168 cc	+14
Cla., William	11 cc	21 cc	196 cc	193 cc	+3
Total	312 cc	438 cc	2898 cc	2891 cc	

and nose piece at various intervals during a test. Any outward leakage of oxygen would cause a slight condensation of moisture on the metal. This was done in all the following tests and the variation became less.

The foregoing tests served as for practice before starting on the ones in this present series.

C. RESULTS

1. The Raw Material

Tables 4 and 5 give the best reading obtained for each child at each measurement of basal metabolism. Each table is composed as follows:

The top line gives the institutional number, sex, birth month and year, and code number of racial stock. The significance of these code numbers is as follows:

1. United States and Nordic mixed
2. Northern Europe
3. Italian
4. Jewish
5. American Negro

There are ten main columns in Table 4, for boys. They contain data as follows, from left to right:

1. Stature in centimeters
2. Increment in stature since last measurement, in centimeters, and adjusted to 1 year.
3. Weight in kilograms
4. Increment in weight since last measurement, or adjusted to 1 year
5. Age in years (measurement made during birth month)
6. Best test of cubic centimeters of O_2 consumed per minute
7. Standard O_2 consumption (Normal) of Sanborn
8. Percentage departure of 6 from 7
9. Standard O_2 consumption of Harris and Benedict
10. Percentage departure of 6 from 9

In a few cases the child was not measured at his birth month, or the measurement for some one year was omitted. In such cases the increments are adjusted

TABLE 4

DATA FOR BOYS

1	2	3	4	5	6	7	8	9	10
#4491	M.	12/1920	3						
140.0	---	38.5	---	11	181	185	-2	176	+3
145.5	5.5	41.1	2.6	12	188	190	-1	184	+2
150.5	5.0	46.1	5.0	13	220	212	+4	196	+12
158.2	7.7	50.1	4.0	14	203	236	-14	216	-6
162.6	4.4	59.7	9.6	15	229	248	-8	231	-1
#5246	M.	10/1919	1						
140.5	---	36.2	---	12	166	180	-8	170	-2
155.0	7.3	43.3	3.6	14	194	213	-9	193	0
156.0	1.0	46.5	3.2	15	215	217	-1	198	+9
163.9	7.9	53.6	7.1	16	227	222	+2	218	+4
169.7	5.8	57.1	3.5	17	226	233	-3	229	-1
173.4	3.7	68.6	11.5	18	243	244	-1	253	-4
#3717	M.	2/1919	1						
142.0	---	33.3	---	12-	149	170	-12	167	-11
145.0	4.5	33.5	0.3	12+	171	171	0	168	+2
148.0	6.0	36.5	6.0	13	162	180	-10	---	---
154.0	6.0	41.5	5.0	14	188	205	-8	189	0
162.3	8.3	48.9	7.4	15	223	229	-3	209	+6
168.0	5.7	54.5	3.6	16	246	242	+2	222	+11
170.2	2.2	61.3	6.8	17	244	242	+1	237	+3
#4703	M.	6/1919	4						
151.0	---	39.9	---	12+	179	188	-5	185	-3
154.0	6.0	42.7	5.6	13	185	192	-4	194	-5
158.0	4.0	47.5	4.8	14	193	220	-12	212	-9
162.7	4.7	50.0	2.5	15	199	230	-13	212	-6
167.4	4.7	53.1	3.1	16	198	224	-11	220	-10
169.7	2.3	59.5	6.4	17	194	237	-18	235	-17
176.4	6.7	70.4	10.9	18	220	251	-12	258	-15
#4227	M.	5/1922	5						
134.4	---	29.0	---	10	167	157	+6	157	---
137.5	3.1	34.1	5.1	11	173	173	+0	165	+5
142.5	5.0	39.3	5.2	12	170	178	-5	180	-6
147.1	4.6	43.7	4.4	13	189	195	-3	190	0
157.7	10.6	50.1	6.4	14	212	226	-7	205	+3
162.1	4.4	66.5	16.4	15	226	261	-13	243	-7
#4228	M.	5/1921	5						
146.6	---	37.2	---	11	187	181	+3	181	---
151.0	4.4	43.5	6.3	12	191	206	-7	191	0
156.4	5.4	48.6	5.1	13	192	206	-7	208	-8
160.5	4.1	51.3	2.7	14	195	230	-15	214	-9
164.4	3.9	54.1	2.8	15	207	240	-14	221	-6
172.6	8.2	63.9	9.8	16	251	251	0	246	+2
#5517	M.	8/1919	4						
1	2	3	4	5	6	7	8	9	10
145.0	---	24.5	---	12	151	159	-5	150	0
148.1	3.1	34.4	9.9	13	145	174	-17	173	---
152.0	3.9	47.8	13.4	14	195	216	-10	199	-2
157.0	5.0	53.3	5.5	15	214	231	-7	214	0
162.8	5.8	56.9	3.6	16	187	227	-18	225	-17
165.5	2.7	56.8	-.1	17	179	211	-15	228	-21
#4688	M.	2/1922	5						
128.0	---	26.6	---	6	142	149	-5	149	-5
141.9	3.7	32.1	1.5	10	164	167	-2	167	---
147.5	5.6	38.4	6.3	11	184	185	-1	181	+2
153.5	6.0	43.1	4.7	12	196	194	+1	193	+2
158.5	5.0	46.7	3.6	13	207	218	-5	204	+1
166.0	7.5	53.8	7.1	14	242	239	+1	221	+9
172.6	6.6	60.0	6.2	15	239	260	-8	239	0
#4738	M.	2/1921	4						
137.0	---	28.4	---	11	152	155	-2	156	---
139.0	2.0	33.9	5.5	12	167	173	-3	166	0
145.0	6.0	40.3	6.4	13	181	188	-4	182	0
151.2	6.2	41.7	1.4	14	178	202	-12	188	-5
157.5	6.3	46.2	4.5	15	183	218	-16	200	-8
164.3	6.8	52.0	5.8	16	245	220	+11	216	+13
#5373	M.	1/1919	1						
150.5	---	39.2	---	13	165	181	-9	184	-10
158.5	8.0	46.2	7.0	14	212	222	-5	201	+5
166.3	7.8	54.1	7.9	15	224	239	-6	222	+1
170.3	4.0	57.8	3.7	16	229	236	-3	232	-1
171.4	1.1	59.6	1.8	17	212	239	-11	235	-10
#4336	M.	10/1921	1						
125.5	---	27.4	---	10	143	152	-6	152	-6
133.4	7.9	28.9	1.5	11	154	161	-4	155	0
138.0	4.6	33.3	4.4	12	162	171	-5	165	-2
143.0	5.0	33.4	0.1	13	161	170	-5	163	-1
#3652	M.	10/1919	1						
145.5	---	40.4	---	12	191	189	+1	182	+5
150.0	4.5	42.3	1.9	13	180	192	-6	188	-4
155.0	5.0	44.0	1.7	14	218	213	+2	195	+12
159.6	4.6	48.5	4.5	15	207	226	-8	206	0
166.6	7.0	53.4	4.9	16	243	223	+9	219	+11
172.0	5.4	64.0	10.6	17	268	252	+6	245	+9
#4120	M.	3/1919	1						
1	2	3	4	5	6	7	8	9	10
135.6	---	27.2	---	13	165	150	+10	150	+10
141.3	5.7	30.4	3.2	14	157	168	-7	156	0
150.5	9.2	38.2	7.8	15	177	194	-9	178	0
157.0	6.5	42.5	4.3	16	206	213	-3	193	+7
159.1	2.1	47.5	5.0	17	204	209	-2	203	0
162.0	2.9	48.1	0.6	18	202	201	0	205	+1
#4847	M.	8/1920	3						
142.5	---	34.0	---	11	161	173	-7	169	-5
153.0	5.3	44.1	5.1	13	232	210	+10	194	+20
153.0	---	43.8	---	13	229	210	+9	194	+18
163.0	10.0	53.5	9.7	14	248	236	+5	220	+12
168.5	5.5	60.2	6.7	15	244	254	-4	236	+3
#4848	M.	6/1923	3						
130.5	---	29.0	---	9	159	157	+2	157	+1
135.5	5.0	33.1	4.1	10	172	170	+1	163	+6
141.5	6.0	37.5	4.4	11	166	182	-9	182	-9
146.1	4.6	38.9	1.4	12	175	186	-6	180	-3
152.4	6.3	44.5	5.6	13	192	212	-9	196	-2
160.1	7.7	49.7	5.2	14	229	228	0	210	+9
#5190	M.	10/1919	1						
150.5	---	38.0	---	12	173	184	-6	181	-4
156.5	6.0	41.9	3.9	13	199	194	+3	192	+4
164.0	7.5	48.2	6.3	14	205	229	-12	210	-2
171.0	7.0	53.5	5.3	15	194	245	-21	223	-13
177.0	6.0	60.0	6.5	16	202	247	-18	241	-16
#5214	M.	7/1919	5						
138.0	---	32.0	---	12	166	167	-1	160	+4
148.0	5.0	37.9	3.0	14	165	192	-14	179	-8
#5580	M.	7/1919	3						
134.5	---	27.8	---	12	129	153	-16	150	-14
139.6	5.1	31.7	3.9	13	153	166	-8	166	-8
146.0	6.4	36.4	4.7	14	181	188	-4	174	+4
153.5	7.5	43.3	6.9	15	167	206	-19	190	-12
159.5	6.0	50.7	7.4	16	189	214	-12	209	-10
162.0	2.5	54.6	3.9	17	212	222	-5	218	-3
162.3	0.3	56.4	1.8	18	214	215	-1	220	-3
#4863	M.	10/1920	3						
133.5	---	29.4	---	11	161	159	+1	154	+5
142.0	4.2	34.0	2.3	13	190	173	+10	167	+14
145.6	3.6	36.2	2.2	14	186	180	+3	173	+7
151.5	5.9	41.2	5.0	15	206	202	+2	186	+11
159.7	8.2	51.7	10.5	16	239	216	+11	213	+12
164.0	4.3	59.4	7.7	17	223	232	-4	231	-3
#5521	M.	7/1923	3						
1	2	3	4	5	6	7	8	9	10
118.4	---	23.0	---	9	144	135	+7	135	+6
121.5	3.1	25.4	2.4	10	129	145	-11	145	-11
125.0	3.5	27.3	1.9	11	139	151	-8	148	-12
129.0	4.0	30.1	2.8	12	161	161	0	150	+7
133.8	4.8	32.3	2.2	13	158	167	-5	157	0
138.3	4.5	38.0	5.7	14	162	184	-12	170	-5
#3376	M.	7/1921	1						
140.0	---	31.2	---	11	182	164	+11	164	+11
144.0	4.0	33.3	2.1	12	178	171	+4	168	+6
148.0	4.0	36.4	3.1	13	181	180	+1	175	+3
153.0	5.0	41.4	5.0	14	182	204	-13	186	-2
157.7	4.7	43.5	2.1	15	202	214	-6	194	+4
163.3	5.6	49.0	5.5	16	230	213	+8	211	+9
#5838	M.	9/1920	4						
135.3	---	28.3	---	12	131	155	-15	154	-15
139.3	4.0	30.7	2.4	13	136	163	-17	157	-13
143.6	4.3	33.9	3.2	14	147	173	-15	181	-18
148.0	4.4	37.0	3.1	15	162	210	-23	196	-16
153.0	5.0	39.7	2.7	16	170	187	-9	183	-7
159.6	6.6	42.7	3.0	17	174	200	-13	194	-10
#5839	M.	2/1918	4						
145.0	---	33.8	---	15	151	180	-16	167	-10
148.7	3.7	37.6	3.8	16	163	194	-16	177	-8
#5453	M.	9/1923	2						
121.0	---	22.6	---	8	136	133	+2	133	+2
124.9	3.9	24.2	1.6	9	146	139	+5	139	+5
130.0	5.1	26.3	2.1	10	156	148	+5	140	+11
134.0	4.0	28.4	2.1	11	148	155	-5	152	-3
138.0	4.0	30.8	2.4	12	151	164	-8	157	-4
141.0	3.0	34.5	3.7	13	167	174	-4	167	0
146.0	5.0	37.4	2.9	14	177	189	-6	174	+2
#5645	M.	10/1921	4						
131.5	---	29.6	---	10	167	160	+4	153	+9
135.5	4.0	30.4	0.8	11	152	162	-6	155	-2
139.0	3.5	32.7	2.3	12	164	169	-3	162	+1
142.5	3.5	34.6	1.9	13	176	174	+1	156	+12
151.6	9.1	43.2	8.6	14	207	204	+1	190	+9
157.0	5.4	47.5	4.3	15	205	223	-8	202	+1
161.3	4.3	54.8	7.3	16	---	221	---	219	---
#2780	M.	5/1919	3						
136.0	---	29.8	---	14	160	161	-1	151	+6
140.0	4.0	29.3	-.5	15	171	167	+2	153	+12
143.0	3.0	30.9	1.6	16	167	176	-5	158	+6
147.5	4.5	35.8	4.9	17	181	175	+5	170	+6

TABLE 4 (Continued)

1	2	3	4	5	6	7	8	9	10
#3641	M.	2/1919	3						
131.1	---	30.7	---	13	155	162	-4	163	-5
133.5	2.4	33.1	2.4	14	184	172	+7	157	+17
138.2	4.7	36.3	3.2	15	179	180	-1	167	+7
144.0	5.8	40.3	4.0	16	205	193	+6	178	+15
150.2	6.2	45.7	5.4	17	209	196	+7	192	+9
154.5	4.3	50.2	4.5	18	203	198	+3	203	0
#3649	M.	1919	1						
140.8	---	31.4	---	13	152	166	-8	166	-8
148.3	7.5	38.1	6.7	14	182	192	-5	178	+2
152.0	3.7	42.9	4.8	15	170	206	-17	189	-10
153.2	1.2	45.6	2.7	16	182	199	-9	193	-6
154.3	1.1	46.3	0.7	17	185	201	-8	196	-6
154.8	0.5	48.0	1.7	18	185	195	-5	199	-7
#3720	M.	12/1921	1						
137.7	---	37.3	---	10	184	182	+1	181	+2
143.5	5.8	41.5	4.2	11	173	191	-9	183	-5
147.8	4.3	43.3	1.8	12	195	220	-11	207	-6
154.4	6.6	43.0	-.3	13	196	210	-7	191	+3
158.9	4.5	52.5	9.5	14	185	232	-20	214	-13
163.2	4.3	56.5	4.0	15	207	241	-14	224	-8
#3643	M.	7/1920	1						
138.0	---	31.7	---	11	149	166	-10	161	-7
143.0	5.0	35.5	3.8	12	157	177	-12	177	-11
150.2	7.2	42.5	7.0	13	176	193	-9	180	-2
158.0	7.8	49.6	7.1	14	181	227	-20	208	-13
162.5	4.5	55.2	5.6	15	185	239	-23	218	-15
164.5	2.0	57.0	1.8	16	200	230	-13	226	-12
#3411	M.	12/1916	1						
146.0	---	38.2	---	13-	171	184	-7	178	-4
153.5	5.6	44.8	5.0	14	193	210	-8	195	-1
161.0	7.5	50.4	5.6	15	229	230	0	211	+9
167.0	6.0	57.5	7.1	16	230	249	-8	228	+1
169.0	2.0	60.9	3.4	17	226	241	-6	235	-4
#5585	M.	6/1923	4						
119.0	---	22.2	---	9	157	131	+20	131	+20
124.0	5.0	24.0	1.8	10	144	139	+4	137	+5
125.0	1.0	27.3	3.3	11	154	151	+2	152	+1
#3928	M.	4/1922	1						
127.2	---	25.4	---	10	164	145	+13	145	+13
130.5	3.3	27.6	2.2	11	149	155	-4	147	+1
135.0	4.5	29.5	1.9	12	159	155	+3	155	+3
140.5	5.5	33.5	4.0	13	154	171	-10	165	-7
145.0	4.5	35.6	2.1	14	171	184	-7	170	+1
152.5	7.5	38.2	2.6	15	166	196	-15	180	-8
#4866	M.	12/1919	4						
127.3	---	28.2	---	12	165	154	+6	154	+6
129.0	1.8	30.6	2.4	13	141	162	-13	150	-6
136.5	7.5	35.9	5.3	14	171	177	-3	165	+4
141.0	4.5	38.5	2.6	15	182	185	-2	172	+6
#6669	M.	12/1920	4						
134.7	---	30.7	---	12+	147	162	-9	164	-9
148.6	2.1	39.9	5.0	14	144	188	-24	181	-20
155.7	7.1	47.6	7.7	15	190	219	-13	202	-6
159.7	4.0	52.1	4.5	16	168	219	-23	---	---
#5654	M.	12/1921	1						
117.4	---	22.2	---	10	151	131	+15	131	+15
120.5	3.1	24.1	1.9	11	152	139	+9	134	+13
124.5	4.0	26.3	2.2	12	139	147	-5	139	0
129.0	4.5	27.3	1.0	13	155	152	+2	144	+8
131.8	2.8	30.5	3.2	14	166	162	+2	150	+11
#5074	M.	4/1920	1						
133.1	---	27.0	---	12	131	150	-13	150	-13
135.5	2.4	29.1	2.1	13	166	157	+6	153	+9
139.5	4.0	30.5	1.4	14	175	167	+5	156	+12
145.0	5.5	33.6	3.1	15	178	179	-1	167	+7
149.3	4.3	37.9	4.3	16	188	179	+5	177	+6
154.4	5.1	43.3	5.4	17	185	196	-6	191	-3
#3363	M.	5/1919	1						
139.5	---	30.7	---	12+	158	163	-3	158	0
144.3	6.4	31.6	1.2	13	153	166	-8	166	-8
149.5	5.2	39.1	7.5	14	187	186	+1	181	+3
159.0	9.5	48.5	9.4	15	226	226	0	207	+9
164.0	5.0	53.0	4.5	16	235	238	-1	218	+8
#4464	M.	6/1920	3						
130.9	---	28.8	---	11	149	156	-4	155	-4
133.8	2.9	27.5	-1.3	12	162	152	+7	152	+7
136.0	2.2	31.5	4.0	13	182	166	+10	156	+17
140.0	4.0	33.0	1.5	14	185	170	+9	162	+14
144.0	4.0	36.3	3.3	15	180	184	-2	171	+5
151.0	7.0	40.5	4.2	16	194	186	+4	182	+7
155.5	4.5	46.7	6.2	17	209	207	+1	200	+5
#6155	M.	1/1924	1						
121.0	---	23.5	---	9	143	139	+3	137	+4
124.0	3.0	24.2	0.7	10	146	140	+4	140	+4
130.0	6.0	27.0	2.8	11	157	150	+5	146	+8
131.5	1.5	27.6	0.6	12	163	152	+7	148	+10
136.0	4.5	30.0	2.4	13	200	164	+22	155	+29
#5502	M.	10/1920	3						
140.0	---	30.5	---	11	156	161	-3	155	+1
146.0	6.0	32.3	1.8	12	189	168	+13	160	+18
149.5	3.5	36.2	3.9	13	188	180	+4	176	+7
157.0	7.5	40.0	3.8	14	187	188	-1	190	-2
165.5	8.5	45.6	5.6	15	216	225	-4	205	+5
170.7	5.2	47.9	2.3	16	242	219	+10	212	+14
171.7	1.0	52.3	4.4	17	223	227	-2	220	+1
#7075	M.	11/1919	4						
137.0	---	33.4	---	12-	146	171	-15	163	-10
143.3	4.7	39.0	4.2	13	165	186	-11	177	-7
147.5	4.2	43.2	4.2	14	180	202	-11	188	-4
#3565	M.	12/1919	1						
143.9	---	34.4	---	12	171	174	-2	174	-2
149.5	5.6	38.9	4.5	13	213	188	+13	182	+17
158.0	8.5	46.4	7.5	14	215	220	-2	201	+7
165.0	7.0	52.2	5.8	15	256	236	+8	217	+18
169.5	4.5	54.3	2.1	16	230	229	0	224	+3
#5607	M.	9/1920	3						
129.0	---	30.3	---	11	153	161	-5	152	+1
132.5	3.5	30.9	0.6	12	136	164	-17	162	-16
136.0	3.5	33.1	2.2	13	156	170	-8	160	-3
140.3	4.7	38.5	5.4	14	159	185	-14	174	-9
#4985	M.	3/1919	3						
143.8	---	34.5	---	13	173	174	-1	174	-1
147.7	3.9	37.4	2.9	14	176	191	-8	176	0
157.8	10.1	46.0	8.6	15	213	219	-3	200	+7
164.0	6.2	53.2	7.2	16	218	222	-2	218	0
#4745	M.	11/1920	1						
135.0	---	32.8	---	11	165	170	-3	162	+2
138.8	3.8	35.1	2.3	12	161	176	-9	167	-4
142.5	3.7	39.9	4.8	13	194	188	+3	179	+8
#5591	M.	10/1918	3						
134.1	---	29.6	---	12	163	159	+3	160	+2
137.3	3.2	33.6	4.0	13	169	171	-1	163	+4
142.5	5.2	38.0	4.4	14	165	187	-12	173	-5
146.6	4.1	40.2	2.2	15	163	194	-16	180	-9
#5610	M.	12/1920	3						
130.3	---	28.7	---	12	153	157	-3	149	+3
134.5	4.2	31.0	2.3	13	183	164	+12	156	+17
140.0	5.5	34.7	3.7	14	172	176	-2	166	+4
145.0	5.0	39.7	5.0	15	198	193	+3	179	+11
153.5	8.5	45.0	5.3	16	196	197	-1	193	+2
#4618	M.	7/1920	1						
129.5	---	26.1	---	11	162	148	+9	144	+12
143.1	13.6	31.5	5.4	12	153	166	-8	165	-7
147.0	3.9	33.6	2.1	13	175	171	+2	170	+3
150.6	3.6	35.5	1.9	14	155	177	-12	173	-10
155.1	4.5	40.5	5.0	15	178	204	-13	186	-4
160.5	5.4	45.0	4.5	16	191	204	-6	199	-4
167.4	6.9	53.7	8.7	17	237	225	+5	221	+7
#4422	M.	8/1919	5						
125.0	---	27.5	---	12	139	152	-9	152	-9
132.4	7.4	29.2	1.7	13	156	157	-1	157	-1
138.0	5.6	34.0	4.8	14	172	173	-1	163	+6
146.5	8.5	41.7	7.7	15	195	197	-1	183	+7
151.7	5.2	48.1	6.4	16	200	201	-1	198	+1
154.8	3.1	53.5	5.4	17	195	213	-8	210	-7
#5593	M.	11/1920	4						
137.0	---	34.1	---	11	158	173	-9	166	-5
141.5	4.5	35.6	1.5	12	173	178	-3	170	+2
146.5	5.0	39.2	3.6	13	211	187	+13	180	+17
#3362	M.	8/1920	1						
145.0	---	28.3	---	11	142	155	-8	157	-10
149.0	4.0	28.0	-.3	12	137	154	-11	154	-11
151.7	2.7	31.4	3.4	13	143	168	-14	167	-14
155.0	3.3	33.0	1.6	14	140	170	-18	173	-19
157.0	2.0	35.5	2.5	15	154	193	-20	178	-13
162.7	5.7	39.1	3.6	16	167	193	-13	191	-13
166.4	3.7	45.6	6.5	17	191	211	-10	202	-5
#5949	M.	5/1921	3						
141.4	---	35.0	---	11	136	176	-23	176	-23
144.0	2.6	39.8	4.8	12	186	188	0	180	+4
149.0	5.0	41.3	1.5	13	171	190	-10	184	-7
#5950	M.	11/1922	3						
137.0	---	32.8	---	10	172	170	+1	165	+4
140.5	3.5	35.6	2.8	11	184	177	+4	168	+10
145.3	4.8	36.0	0.4	12	145	179	-19	174	-17
#4447	M.	11/1919	5						
135.0	---	34.6	---	12	164	174	-6	165	-1
140.7	5.7	39.7	5.1	13	187	188	-1	177	+6
149.0	8.3	46.3	6.6	14	213	212	0	195	+9
155.7	6.7	53.2	6.9	15	212	230	-8	212	0
158.3	2.6	55.8	2.6	16	211	221	-5	219	-4
160.0	1.7	59.7	3.9	17	214	229	-7	228	-6

TABLE 5

DATA FOR GIRLS

1	2	3	4	5	6	7	8	9	10	11	12
#5977	F.	7/1922	1								
142.0	---	31.4	---	10	153	155	-1	---	---	---	---
146.5	4.5	32.0	.6	11	156	157	-1	165	-5	168	-7
152.0	4.7	37.2	4.4	12+	184	175	+5	165	+11	181	+1
156.5	5.4	39.3	2.5	13	171	186	-8	---	---	188	-10
162.0	5.5	47.4	8.1	14	215	210	+1	---	---	208	+2
166.6	4.6	52.9	5.5	15	209	225	-6	---	---	221	-5
#5829	F.	10/1922	1								
129.2	---	27.1	---	10	143	140	+2	138	+4	147	-3
135.8	6.6	31.2	4.1	11	161	156	+5	146	+10	158	+2
142.0	6.2	35.3	4.1	12	161	167	-4	155	+4	170	-5
147.5	5.5	41.5	6.2	13	183	183	0	---	---	182	0
152.6	5.1	49.3	7.8	14	190	204	-7	---	---	203	-6
155.2	2.6	56.1	6.8	15	183	203	-10	---	---	218	-16
#4013	F.	12/1919	1								
142.0	---	30.0	---	12-	165	150	+10	134	+23	161	+3
152.5	7.4	39.3	6.6	13+	186	182	+3	160	+17	184	+2
156.5	6.5	45.2	6.4	14	211	208	+4	171	+23	199	+6
#5138	F.	5/1919	3								
130.7	---	35.7	---	12+	161	170	-5	155	+4	168	-4
142.5	5.1	40.7	6.7	13	141	188	-25	168	-16	181	-22
147.0	4.5	45.9	5.2	14	179	192	-7	173	+3	193	-7
148.5	1.5	46.1	.2	15	165	---	-15	157	+6	193	-15
151.0	2.5	52.2	6.1	16	170	206	-17	---	---	205	-17
150.7	-.3	53.1	.9	17	190	194	-2	---	---	206	-6
150.9	.2	50.0	-3.1	18	170	187	-9	---	---	200	-15
#3633	F.	5/1922	1								
126.4	---	25.1	---	10	141	134	+5	---	---	---	---
130.0	3.6	27.3	2.2	11	144	141	+2	138	+4	146	-1
140.0	10.0	31.5	4.2	12	171	155	+10	138	+24	159	+8
148.4	8.4	36.6	5.1	13	161	172	+5	148	+22	176	+3
152.5	4.1	44.0	7.4	14	172	195	-12	---	---	193	-11
155.0	2.5	46.0	2.0	15	188	201	-6	---	---	198	-5
#5206	F.	10/1922	3								
124.0	---	28.1	---	9	117	144	-19	130	-10	---	---
129.5	5.5	33.0	4.9	10	137	181	-24	137	0	171	-20
135.8	6.3	36.0	3.0	11	151	170	-11	146	+3	168	-10
142.5	6.7	41.3	5.3	12	154	180	-14	161	-4	182	-16
145.4	2.9	42.6	1.3	13	156	186	-16	---	---	186	-16
147.3	1.9	48.1	5.5	14	152	198	-23	---	---	197	-23
146.5	-.8	49.8	1.7	15	168	200	-16	---	---	200	-16
#3925	F.	4/1921	1								
140.8	---	33.0	---	11	138	160	-14	---	---	---	---
147.3	6.5	39.6	6.6	12	164	182	-10	178	-8	183	-10
153.5	6.2	45.9	6.3	13	184	189	-3	189	-3	198	-7
156.7	3.2	50.0	4.1	14	161	209	-23	---	---	208	-23
157.9	1.2	54.1	4.1	15	173	215	-20	---	---	216	-20
158.0	1.1	54.7	6.0	16	173	201	-14	---	---	219	-21
#5880	F.	6/1923	5								
1	2	3	4	5	6	7	8	9	10	11	12
131.5	---	29.8	---	9	141	150	-6	140	0	---	---
136.0	4.5	32.9	3.1	10	151	160	-6	149	+1	159	-5
142.0	6.0	36.8	3.9	11	140	173	-19	157	-11	174	-20
146.3	4.3	38.0	1.2	12	144	184	-22	---	---	181	-20
#5879	F.	6/1924	5								
128.6	---	27.0	---	8	151	140	+8	---	---	---	---
134.5	5.9	31.7	4.7	9	163	157	+4	143	+14	162	0
140.5	6.0	35.8	4.1	10	165	170	-3	152	+9	172	-4
146.0	5.5	38.1	2.3	11	167	184	-9	---	---	183	-9
152.0	6.0	50.0	1.9	12	201	206	-2	---	---	207	-3
159.1	7.1	61.1	1.1	13	246	232	+6	---	---	234	+5
#2843	F.	1/1919	1								
139.8	---	35.4	---	13-	171	168	+2	155	+10	168	+2
143.8	9.4	37.4	4.8	13	163	176	-7	152	+7	---	---
146.3	2.5	44.7	7.3	14	172	191	-10	169	+2	190	-9
148.3	2.0	42.6	-2.1	15	186	188	-1	146	+27	187	0
#4884	F.	10/1921	1								
132.2	---	27.1	---	10-	143	141	+1	142	0	148	-3
140.8	7.5	34.3	6.2	11	154	164	-6	156	-1	167	-8
148.0	7.2	41.8	7.5	12	169	190	-11	187	-10	188	-10
151.5	3.5	46.3	4.5	13	168	212	-20	190	-12	197	-15
154.0	2.5	47.5	1.2	14	170	202	-15	---	---	201	-15
154.0	0.0	49.2	1.7	15	153	206	-25	---	---	203	-25
#3679	F.	2/1921	1								
138.8	---	31.0	---	11	146	154	-5	---	---	---	---
143.0	4.2	33.2	2.2	12	152	161	-6	146	+4	166	-9
148.0	5.0	38.8	5.6	13	176	180	-2	158	+11	181	-3
154.6	6.6	42.8	4.0	14	162	196	-17	---	---	193	-16
157.6	3.0	46.5	3.7	15	195	203	-4	---	---	207	-6
159.1	1.5	52.3	5.8	16	205	200	+2	---	---	213	-4
#5849	F.	1/1921	1								
134.0	---	29.4	---	12	152	149	+2	129	+8	153	-1
139.0	5.0	30.1	0.7	13	156	150	+5	123	+15	157	+1
144.0	4.3	32.7	2.2	14+	164	159	+3	---	---	164	0
148.8	5.2	36.7	4.4	15	135	177	-24	---	---	177	-24
#5348	F.	7/1919	1								
145.6	---	33.1	---	12	162	160	+1	146	+11	167	-3
150.3	4.7	36.3	3.2	13	165	172	-4	148	+11	---	---
156.3	6.0	43.1	6.8	14	175	196	-11	154	+14	193	-9
158.4	2.1	48.0	4.9	15	187	207	-10	164	+14	204	-7
160.7	2.3	51.1	3.1	16	189	200	-6	---	---	211	-10
160.5	-.2	52.7	1.6	17	181	202	-10	---	---	214	-15
#5829	F.	3/1922	2								
1	2	3	4	5	6	7	8	9	10	11	12
145.7	---	36.8	---	10	171	174	-2	---	---	---	---
149.1	3.4	37.8	1.0	11	168	177	-6	168	0	180	-7
154.3	5.2	43.9	6.1	12	205	198	+4	196	+5	197	+4
160.5	6.2	48.0	4.1	13	202	210	-4	---	---	208	-3
165.9	5.4	53.9	5.9	14	243	223	+9	---	---	223	+9
168.5	2.6	60.0	6.1	15	275	236	+17	---	---	239	+15
#6095	F.	10/1924	1								
122.5	---	23.5	---	8	102	128	-20	126	-19	---	---
127.0	5.4	24.1	0.7	9	127	130	-2	134	-5	---	---
132.0	5.0	26.1	2.0	10	135	137	-1	142	-5	146	-8
137.0	5.0	28.7	2.6	11	133	147	-10	---	---	161	-17
143.4	6.4	33.5	4.8	12	148	162	-9	---	---	168	-12
150.7	7.3	38.8	5.3	13	175	182	-4	---	---	182	-4
#6041	F.	12/1923	3								
121.0	---	22.0	---	9	136	123	+9	125	+9	131	+4
125.0	4.0	23.1	1.1	10	143	127	+12	132	+8	134	+7
129.5	4.5	24.4	1.3	11	145	132	+10	---	---	141	+3
#6096	F.	1/1922	5								
140.3	---	39.2	---	11	171	182	-6	156	+10	177	-4
144.0	3.7	46.6	7.4	12	182	191	-5	210	-13	195	-7
146.0	2.0	54.3	7.7	13	189	206	-8	222	---	211	-10
147.5	1.5	56.8	2.5	14	225	212	+6	---	---	216	+4
#5915	F.	9/1924	5								
115.4	---	20.0	---	8	113	116	-3	---	---	---	---
115.5	---	20.0	---	8+	110	116	-5	117	-6	---	---
120.0	4.5	21.6	1.6	9	126	121	+4	124	+1	129	-1
125.0	5.0	24.4	2.8	10	135	132	+2	131	+3	137	-1
128.8	3.8	25.8	1.4	11	161	137	+18	---	---	142	+13
132.6	3.8	27.4	1.6	12	162	142	+14	---	---	147	+10
137.0	4.4	30.0	2.6	13	157	150	+5	---	---	155	+1
#4695	F.	3/1920	3								
140.1	---	32.7	---	12	134	156	-15	146	-8	---	---
144.2	4.1	37.3	4.6	13	162	176	-14	152	0	175	-13
147.5	3.3	42.4	5.1	14	168	181	-7	158	+7	186	-10
151.0	3.5	46.0	3.6	15	163	197	-17	---	---	195	-16
152.0	1.0	49.0	3.0	16	178	189	-6	---	---	201	-11
#4043	F.	12/1919	2								
144.4	---	36.0	---	12	133	170	-22	160	-17	---	---
150.5	6.1	43.1	7.1	13	174	192	-9	176	+1	190	-8
156.0	5.5	50.9	7.8	14	202	210	-3	192	+5	209	-3
160.5	4.5	57.4	6.5	15	188	225	-16	195	-4	224	-16
161.3	0.8	59.5	2.1	16	197	213	-8	---	---	229	-14
162.0	0.7	62.4	2.9	17	207	219	-5	---	---	234	-12
#4840	F.	7/1920	3								
1	2	3	4	5	6	7	8	9	10	11	12
135.8	---	44.5	---	12	194	200	-3	196	-1	---	---
141.2	5.4	53.8	8.7	13	203	200	+2	217	-6	203	0
145.0	3.8	61.4	7.2	14	197	216	-9	230	-14	222	-11
147.2	2.2	60.6	-.8	15	200	218	-8	---	---	221	-10
#8176	F.	12/1919	1								
129.0	---	26.5	---	12	136	139	-2	120	+13	---	---
134.0	5.0	31.0	4.5	13	153	154	-1	127	+20	154	0
138.0	4.0	34.1	3.1	14	147	163	-10	126	+15	163	-10
141.0	3.0	37.5	3.4	15	165	176	-6	127	+30	171	-4
#5364	F.	5/1921	3								
137.5	---	27.1	---	10	136	140	-3	150	-9	153	-11
142.3	4.8	31.2	4.1	11	136	154	-12	---	---	---	---
150.0	12.5	37.5	6.3	12	168	176	-5	169	0	181	-7
156.5	6.5	44.8	7.3	13	158	199	-21	184	-14	198	-20
159.5	3.0	52.5	7.7	14	185	216	-14	---	---	215	-14
160.5	1.0	53.9	1.4	15	212	219	-3	---	---	218	-3
161.0	0.5	56.1	2.2	16	178	208	-14	---	---	222	-20
#5365	F.	5/1921	3								
135.5	---	25.8	---	10	130	136	-4	149	-13	149	-13
140.9	5.4	30.2	4.4	11	146	150	-3	---	---	---	---
147.5	6.6	36.0	5.8	12	177	170	+4	160	+11	175	+1
153.8	6.3	42.2	6.2	13	160	188	-15	172	-7	190	-16
159.0	5.2	49.4	7.2	14	160	211	-24	---	---	211	-24
159.0	0.0	53.0	3.6	15	190	216	-12	---	---	214	-11
159.8	0.8	54.6	1.6	16	181	204	-11	---	---	217	-17
#4092	F.	8/1919	1								
139.5	---	28.1	---	12	139	144	-3	125	+11	154	-10
143.6	4.1	32.0	3.9	13	144	157	-8	131	+10	---	---
147.5	8.0	36.7	4.7	14	134	176	-24	139	+9	178	-24
148.7	1.2	38.4	1.7	15	132	181	-27	134	-1	178	-26
149.5	0.7	41.3	2.9	16	156	173	-10	---	---	183	-15
150.9	1.5	41.0	-.3	17	173	174	-1	---	---	182	-5
#3827	F.	6/1921	5								
137.0	---	26.9	---	11	118	140	-16	149	-21	158	-26
142.7	5.7	31.0	4.1	12	133	154	-14	138	-3	162	-18
149.5	6.8	37.0	6.0	13	127	174	-27	152	-16	178	-28
155.5	6.0	40.5	3.5	14	160	190	-16	---	---	187	-14
158.5	3.0	46.5	6.0	15	160	205	-22	---	---	201	-20
159.9	1.4	50.2	3.7	16	143	198	-28	---	---	209	-31
#3307	F.	5/1920	1								
131.2	---	31.5	---	12	160	155	+3	142	+12	---	---
135.3	4.1	37.3	5.8	13	171	175	-2	152	+12	168	+2
139.5	4.2	43.5	6.2	14	184	180	+2	162	+14	182	+1
140.8	1.3	47.4	3.9	15	190	188	+1	---	---	189	0
142.4	1.6	51.2	3.8	16	199	184	+8	---	---	197	+1
146.0	3.6	55.7	4.5	17	227	193	+18	---	---	209	+9

TABLE 5 (Continued)

1	2	3	4	5	6	7	8	9	10	11	12
#4512	F.	7/1920	1								
123.1	---	23.1	---	11	103	127	-19	128	-19	---	---
129.3	6.2	26.7	3.6	12	126	139	-9	120	+5	---	---
135.5	12.4	33.8	7.1	13	137	163	-16	139	-1	162	-15
143.0	7.5	39.4	5.6	14	137	182	-25	150	-9	178	-23
146.5	3.5	43.7	4.3	15	146	168	-22	---	---	188	-22
146.5	0.0	44.1	0.4	16	144	175	-18	---	---	186	-22
146.3	-.2	45.1	1.0	17	136	176	-23	---	---	189	-28
#5541	F.	11/1920	1								
141.5	---	36.3	---	11	178	172	+3	156	+14	172	+3
146.0	4.5	38.3	2.0	12	186	179	+4	169	+10	179	+4
151.5	5.5	41.1	2.8	13	187	188	-1	168	+11	186	0
157.2	5.7	44.9	3.8	14	189	201	-6	169	+11	199	-5
163.5	6.3	50.7	5.8	15	221	216	+2	---	---	212	+4
166.8	3.3	52.9	2.2	16	218	207	+5	---	---	219	0
#5897	F.	6/1923	1								
125.0	---	24.1	---	9	101	130	-22	132	-23	---	---
131.0	6.0	27.4	3.3	10	118	142	-17	140	-16	147	-20
136.5	5.5	30.3	2.9	11	136	151	-10	149	-9	157	-13
143.5	7.0	35.0	4.7	12	139	167	-17	---	---	170	-18
149.5	6.0	39.2	4.2	13	160	181	-12	---	---	182	-12
157.2	7.7	42.8	3.6	14	168	198	-20	---	---	195	-19
#3338	F.	7/1919	1								
-----	---	34.5	---	12[6]	160	165	-3	155	+3	---	---
145.8	---	37.2	5.2	13	187	174	+7	152	+23	---	---
152.5	6.7	44.4	7.2	14	173	195	-11	165	+5	193	-10
155.0	2.5	53.1	8.7	15	203	213	-5	182	+13	212	-4
157.5	2.5	52.4	-.7	16	159	199	-20	---	---	211	-25
157.5	0.0	58.3	5.9	17	195	208	-6	---	---	221	-12
#5182	F.	12/1922	1								
108.5	---	18.7	---	9	120	112	+7	107	+11	---	---
112.5	4.0	21.1	2.4	10	107	121	-12	112	-4	---	---
117.5	5.0	23.2	2.1	11	121	128	-5	120	0	---	---
121.5	4.0	26.0	2.8	12	120	137	-12	116	+3	137	-12
127.0	5.5	27.9	1.9	13	131	144	-9	---	---	144	-9
#4879	F.	12/1922	1								
118.5	---	19.6	---	8[6]	136	114	+19	122	+11	---	---
127.3	3.2	22.9	1.2	11+	127	127	0	134	-5	136	+7
130.0	2.9	28.1	5.7	12	132	144	-8	125	+6	147	-10
135.3	4.2	28.4	0.2	13+	139	145	-4	116	+20	150	-7
138.5	5.1	30.3	3.1	14-	146	152	-4	---	---	155	-6
#3481	F.	6/1919	3								
148.0	---	39.0	---	13-	177	182	-3	160	+11	---	---
148.0	0.0	40.4	2.8	13	158	189	-16	164	-4	183	-15
152.5	4.5	50.8	10.4	14	180	205	-12	192	-6	207	-13
155.4	2.9	57.0	6.2	15	215	220	-2	194	+11	220	-2
155.2	-.2	50.7	-6.3	16	172	195	-12	---	---	205	-16
#5662	F.	6/1919	2								
131.5	---	31.3	---	12[6]	154	155	-1	138	+11	---	---
134.1	5.2	32.2	1.8	13	142	157	-10	131	+8	---	---
139.5	5.4	39.1	6.9	14	151	173	-13	147	+3	174	-13
142.5	3.0	41.5	2.4	15	167	179	-7	142	+17	180	-7
144.4	1.9	44.6	3.1	16	154	176	-12	---	---	186	-17
145.4	1.0	46.3	1.7	17	162	179	-10	---	---	189	-14
#2663	F.	4/1918	1								
138.2	---	27.3	---	9	139	142	-2	---	---	---	---
148.5	6.2	34.6	4.5	13	166	166	0	143	+16	173	-4
154.0	4.4	40.2	4.3	14	184	186	-1	150	+23	186	-1
159.5	5.5	49.9	9.7	15	189	212	-11	171	+10	210	-10
160.0	0.5	48.1	-1.8	16	185	197	-6	151	+18	205	-10
161.6	1.6	52.0	3.9	17	177	200	-11	---	---	213	-17
162.0	0.4	52.0	0.0	18	217	192	+13	---	---	213	+1
162.5	0.5	48.5	-3.5	19	164	187	-12	---	---	203	-19
#5833	F.	1/1920	1								
144.7	---	37.2	---	12	154	174	-11	164	-6	---	---
150.5	5.8	43.5	6.3	13	186	192	-3	176	+6	191	-3
152.6	2.1	50.0	6.5	14	203	204	0	188	+8	203	0
153.6	1.0	50.8	0.8	15	198	209	-5	175	+13	206	-4
153.6	0.0	53.1	2.3	16	193	198	-2	---	---	209	-8
#4246	F.	11/1919	2								
146.0	---	33.0	---	12	163	160	+2	146	+11	168	-3
153.5	7.5	38.7	5.7	13	166	181	-8	160	+4	184	-10
155.5	2.0	40.4	1.7	14	166	190	-13	150	+11	187	-11
158.3	2.8	46.4	6.0	15	184	204	-10	157	+17	201	-8
158.6	0.3	44.7	-1.7	16	180	192	-6	---	---	196	-8
158.4	-.2	47.0	2.3	17	178	190	-6	---	---	201	-11
#4982	F.	5/1920	2								
-----	---	34.6	---	12-	127	165	-23	---	---	---	---
140.3	---	36.8	6.6	12	157	174	-10	173	-9	---	---
147.0	6.7	45.8	9.0	13	181	196	-8	189	-4	195	-7
152.7	5.7	54.8	9.0	14	192	215	-11	207	-7	215	-10
157.0	4.3	53.1	-1.7	15	156	216	-28	---	---	214	-28
158.0	1.0	59.6	6.5	16	172	210	-18	---	---	228	-25
#4729	F.	8/1920	1								
129.5	---	25.0	---	11	123	134	-8	138	-11	---	---
133.6	4.1	27.7	2.7	12	131	142	-6	125	+5	---	---
141.5	7.9	34.3	6.6	13	170	165	+3	139	+22	167	+2
147.0	5.5	38.9	4.6	14	170	181	-6	147	+15	179	-5
151.2	4.2	41.1	2.2	15	173	187	-8	---	---	186	-7
152.7	1.5	40.0	-1.1	16	146	174	-16	---	---	184	-21
152.5	-.2	42.7	2.7	17	163	179	-9	---	---	186	-12
#5241	F.	6/1920	1								
-----	---	26.3	---	12-	145	139	+4	116	+23	---	---
133.7	---	30.8	6.8	12+	172	154	+12	138	+25	---	---
147.4	3.4	38.9	4.1	14+	178	181	-2	146	+22	179	0
150.3	3.9	40.5	2.1	15	178	185	-4	---	---	182	-2
151.5	1.2	43.4	2.9	16	175	179	-2	---	---	188	-7
#4085	F.	7/1920	2								
143.5	---	31.6	---	11	149	155	-4	161	-7	165	-10
149.6	6.1	35.2	3.6	12	155	167	-7	155	0	---	---
155.0	5.4	39.5	4.3	13	164	182	-10	160	+3	187	-12
160.0	5.0	44.3	4.8	14	158	202	-22	165	-4	199	-20
162.1	2.1	46.3	2.0	15	156	209	-25	---	---	204	-24
162.7	0.6	51.6	5.3	16	174	202	-14	---	---	215	-19
163.0	0.3	52.0	0.4	17	182	202	-10	---	---	214	-15
#4147	F.	2/1920	3								
138.4	---	28.9	---	12	145	147	-1	129	+12	---	---
145.4	7.0	36.4	7.5	13	173	172	+1	148	+17	173	0
151.0	5.6	42.3	5.9	14	168	189	-11	160	+5	188	-10
155.0	4.0	43.9	1.6	15	209	198	+6	---	---	194	+8
156.5	1.5	49.3	5.4	16	208	193	+8	---	---	205	+1
161.0	4.5	53.6	4.3	17	210	203	+3	---	---	216	-3
#4205	F.	4/1920	2								
-----	---	31.0	---	9	150	154	-3	---	---	---	---
152.1	---	38.9	2.6	12	145	181	-20	172	-16	---	---
156.0	3.9	47.1	8.2	13	192	205	-6	193	0	202	-5
158.0	2.0	50.3	3.2	14	178	212	-16	188	-6	209	-16
159.0	1.0	51.1	0.8	15	173	214	-19	---	---	211	-18
159.0	0.0	51.1	0.0	16	197	199	-1	---	---	210	-6
#4734	F.	9/1920	1								
138.0	---	28.4	---	11	156	145	+8	150	+4	155	0
143.8	5.8	31.7	3.3	12	162	155	+5	142	+14	---	---
146.5	2.7	42.1	10.4	13	194	186	+4	172	+14	185	+5
149.5	3.0	41.6	-.5	14	198	188	+5	158	+25	187	+5
151.4	1.9	43.2	1.6	15	183	191	-4	---	---	190	-4
151.5	0.1	44.1	0.9	16	183	179	+2	---	---	189	-3
151.6	0.1	42.0	-2.1	17	191	176	+9	---	---	184	+4
#5250	F.	6/1920	1								
-----	---	27.0	---	12-	136	140	-3	118	+15	---	---
131.4	---	27.8	2.3	12	140	144	-3	125	+12	---	---
136.0	4.6	35.7	7.9	13	159	169	-6	148	+7	166	-4
141.0	5.0	43.1	7.4	14	158	180	-12	162	-2	182	-13
141.2	0.2	46.5	3.4	15	163	187	-13	---	---	188	-13
141.5	0.3	44.0	-2.5	16	142	168	-15	---	---	183	-22
142.0	0.5	45.8	1.6	17	158	175	-10	---	---	185	-15
#3532	F.	11/1919	1								
147.0	---	36.8	---	13	165	173	-5	152	+9	177	-7
149.0	2.0	40.7	3.9	14	163	186	-12	154	+6	185	-12
152.3	3.3	41.5	0.8	15	183	187	-3	145	+26	188	-3
152.9	0.6	44.8	3.3	16	167	183	-9	---	---	192	-13
#5929	F.	11/1921	1								
134.0	---	33.2	---	11	161	160	+1	143	+12	162	0
138.0	4.0	32.5	-.7	12	143	158	-9	146	-1	161	-11
147.5	4.8	39.9	3.7	14	169	184	-8	---	---	182	-7
153.5	6.0	46.0	6.1	15	187	199	-6	---	---	196	-5
#4941	F.	5/1922	4								
126.3	---	25.0	---	10	133	134	-1	---	---	---	---
129.0	2.7	29.7	4.7	11	154	150	+3	137	+12	149	+3
134.0	5.0	32.8	3.1	12	147	159	-8	147	0	160	-8
138.0	4.0	36.6	3.8	13	171	172	-1	---	---	168	+2
142.8	4.8	39.4	2.8	14	176	178	-1	---	---	176	-1
147.7	4.9	44.0	4.6	15	182	189	-4	---	---	189	-4
#5404	F.	8/1922	3								
118.1	---	28.1	---	9	103	116	-11	120	-14	---	---
120.7	2.6	21.5	-6.6	10	113	121	-7	---	---	---	---
124.0	3.3	25.8	4.3	11	122	136	-10	130	-6	---	---
128.0	4.0	28.8	3.0	12	137	147	-7	127	+8	148	-7
130.6	2.6	31.4	2.6	13	144	155	-7	---	---	154	-7
134.0	3.4	31.1	-.3	14	144	154	-7	---	---	155	-7
138.7	4.7	32.7	1.6	15	140	156	-10	---	---	159	-12
#5498	F.	6/1923	1								
122.0	---	19.3	---	8	93	113	-18	126	-26	---	---
126.3	4.3	20.1	0.8	9	112	116	-3	---	---	---	---
131.0	9.0	23.3	3.2	10	85	128	-34	140	-40	135	-37
134.5	3.5	25.5	2.2	11	111	135	-18	145	-23	143	-22
137.0	2.5	28.6	3.1	12	123	145	-15	---	---	155	-20
141.9	4.9	30.0	1.4	13	145	150	-3	---	---	157	-8
149.7	7.8	32.3	2.3	14	152	169	-10	---	---	167	-9
#4078	F.	10/1923	1								
116.0	---	16.8	---	8-	127	111	+14	119	+7	---	---
120.5	3.6	21.2	1.9	9	127	121	+5	124	+2	---	---
125.0	4.5	23.8	2.6	10	133	130	+2	132	+1	---	---
133.4	8.4	25.9	2.1	11	144	137	+5	143	0	146	-1
141.2	7.8	32.3	6.4	12	177	158	+12	---	---	162	+9
148.0	6.8	39.3	7.0	13	174	181	-4	---	---	183	-5
150.8	2.8	47.2	7.9	14	198	199	-1	---	---	197	0
#5375	F.	10/1921	3								
136.5	---	34.3	---	10-	156	164	-5	149	+5	166	-6
146.0	7.4	43.3	7.0	11	185	202	-8	165	+12	190	-3
151.0	5.0	50.5	7.2	12	185	204	-9	223	-17	205	-10
153.5	2.5	56.9	6.4	13	189	217	-13	234	-19	220	-14
154.5	1.0	59.8	2.9	14	197	224	-12	---	---	226	-13
155.0	0.5	59.0	-.8	15	182	223	-18	---	---	224	-19
#6006	F.	11/1921	3								
132.5	---	28.2	---	11	139	148	-6	142	-2	150	-7
138.5	6.0	33.2	5.0	12	145	161	-10	144	-1	163	-11
144.8	6.3	37.8	4.6	13	151	177	-15	156	-3	177	-15
151.0	6.2	44.4	6.6	14	172	194	-11	---	---	192	-10
152.5	1.5	48.4	4.0	15	---	---	---	---	---	200	---
152.5	0.0	48.4	0.0	16	179	202	-11	---	---	199	-10

to 1 year.

In Table 5, for girls, there are 12 columns. Columns 1-8 are the same as above. The others are as follows:

9. Standard O_2 consumption of Benedict
10. Percentage departure of Col. 6 from Col. 9
11. Standard O_2 consumption of Harris and Benedict (boys)
12. Percentage departure of Col. 6 from Col. 11

2. Correlations Between Changes in Basal Metabolism and Changes in Physical Growth

Tables 4 and 5 are the raw material. Their analysis should give us the answer to the question with which we started:- What is the relation between fluctuations in basal metabolism and in physical growth?

A cursory examination of the readings of O_2 consumption in the 6th column shows that this, for any one child, is somewhat variable. Take, for example, the second boy in the table. His readings run: 166, 194, 215, 227, 226, 243. There is an increase with age except that the penultimate reading is not larger than the reading of the preceding year. This increase with age at adolescence corresponds to the findings of Benedict and Talbot (1921), as well as others. The irregularity of one point in the latter half of the above series is inevitable, considering the conditions under which the determination was made, especially the emotional disturbance which all of the children, but some much more than others, experienced. Dr. F. G. Benedict (1935) had his own basal metabolism measured daily for a month. The determinations were strikingly constant; as one would expect in an adult who had every reason for remaining passive. Yet on certain days when he was emotionally disturbed (because one of his family was injured in an automobile accident) his basal determinations increased temporarily about 15 points, or 6.5 per cent.

a. Statistical Methods

Given the table, the question arose as to the best way to use it to get the desired answer. The standards with which our readings are compared were themselves increasing during the period of growth of the child whose basal metabolism we are studying. If all children had their adolescent spurt of growth at the same age the standard would vary as the individual does and there would be no differentials indicative of the effect on metabolism of rapid growth at the time of the spurt. But just because the age of the spurt varies greatly its effect on the standard is to produce a flattened plateau, on which peaks may be discerned, although reduced in salience. The percentage departures from standard O_2 consumption were tabulated and variations in these were correlated with variations in corresponding height and weight increments.

A second method would be to compare the increase in height or weight during any series of annual intervals with the smoothed series of height and weight of the same child. Given a similar smoothed series of O_2 consumption of the same child during the same period, one may compare with it the basals actually found in that child. Then one may correlate deviations in body size from the smoothed series for size with deviations in O_2 consumption from its smoothed series. Both methods were resorted to.

Even if there is a relation between change in speed of growth and metabolism, it does not follow that the maximum correlation between the two events must occur at precisely the same time. Owing to the fact that the children were measured anthropometrically not only on the birth month but also 6 months later, it

has been possible to test the hypothesis that the maximum change in O_2 consumption occurs during the 6 months period either before or after the basal determination. In this determination the middle of the period between the two determinations, viz. 3 months, is assumed as the age of the average change in growth during the 6 month interval.

Method of Mass Correlations Based on Departures from Standards

The problem presented was to find some sort of relationship between change in basal metabolism and change in rate of growth, both in height and weight. The basal metabolism values were figured as follows: The standard reading of an individual of the sex, age and dimensions of the subject was available from prepared tables. The departure of the individual's basal metabolism was found by subtracting the best test value from the standard value. This difference was divided by the standard value to give the percentage departure, P.D.S. These percentages could not be used for correlation purposes since a value of -6 per cent might represent a decreased metabolism for one individual and an increased metabolism for the other. The obvious way to show the trends was to subtract the first of two successive annual percentage deviations from the second. Then a plus value represents an increased metabolism in the yearly period in which this metabolism is calculated. These values were correlated with corresponding changes in height and weight increment.

These changes in height and weight increment could have been found by graphing the accompanying data, but this was not necessary since we were already in possession of increment curves of these individuals which had the advantage of being more accurate than those tabulated since they were taken in six month intervals and had been adjusted for several variations on the basis of the findings of Davenport, Steggerda and Draeger (1934) as follows:

If the height of an individual is measured in December as 1408 mm., in June as 1434 mm., and in the following December as 1458 mm., then the increment from December to June will be 26 mm., or 52 mm. per year and the center of the period over which it is calculated is March. The increase in the next period will be 48 mm. per year centered at September. Now in the study just cited we found that in certain six month periods the individual grew more than in others; so a correction factor was determined to minimize these seasonal variations. It was found that for the six month period centered at March the individual tended to have an excess growth that amounted to 0.312 per cent of his total stature, and in September the growth was short by 0.312 per cent of his total stature.

In March the individual's stature was approximately 1421 mm., so the excess was 1421 multiplied by 0.00312 = 4.43 mm. per year, making his adjusted increment 52 - 4.43 = 47.6 mm. per year.

In August his stature was approximately 1446 mm., so the shortage was 1446 x 0.00312 = 4.51 mm. per year, making his adjusted increment 52.5 mm. per year.

These values were computed for all available measurements and adjusted graphs made.

Using the increment graph and the basal metabolism data of M.A. No. 1, ♂ #4491, we get the data of Table 6.

The figures in the last two columns were used for mass correlations. The different ages were not taken into consideration.

Since it was possible that the basal metabolism rate might change before the body size and then, as a result, the yearly increment be increased or vice versa, the values of column 1 were changed 3 months each way causing a corresponding change in columns 2 and 5, but not in columns 3 and 6. From these changed data similar correlations were obtained.

TABLE 6

ILLUSTRATION OF METHOD OF ADJUSTMENT OF INCREMENT VALUES OF HEIGHT AND WEIGHT

1 Age	2 Height Increment	3 P.D.S. in B.M.	4 Age	5 Change in Increment	6 Change in P.D.S. Basal metabolism
11	48	-3			
			11/6	-4	2
12	44	-1			
			12/6	13	5
13	57	+4			
			13/6	13	-18
14	70	-14			
			14/6	-18	6
15	52	-8			

b. Method of Mass Correlation Based on Departures from the Individual's Base Line

In doing correlations using metabolic values, it was observed that some individuals at all times had a high value while others had always very low. Also, the great majority of values were negative when the Sanborn standards were used because the other standards were not complete over the age range in use. Another possible chance for error lay in the fact that the standards were not compiled for this particular type of children which is known to be subnormal in many respects.

Another disadvantage of mass correlations that are based on "standards" is that large departures are apt to be due to observational difficulties and emotional instability of the child and one of these departures will outweigh in effect those of several good subjects who show small departures. In an individual study a series of small departures will give just as high a correlation as a series of large departures and will carry just as much weight in an average that is used to represent the whole group.

To overcome any objections which might arise along these lines, the computation of correlations based on departure from the individual's base line was undertaken. The correlations are sometimes referred to below as "intra-individual" correlations.

The complete data used in the correlations referred to individual base lines were used to make four mass correlations of males and of females, respectively, between height or weight increment departures on the one hand and O_2 consumption departure on the other. These can be used for comparison with the average of the individual correlations. The average of the individuals is more uniform and, as explained, probably more reliable than are averages based on departures from a single standard.

The method of procedure may be illustrated by an example. The data of John D. No. 4848 in respect to weight and O_2 consumption are as follows:

Weight	O_2
29.0	159
33.1	172
37.5	166
38.9	175
44.5	192
49.7	229

We have here 6 years of measurements embracing 5 yearly periods. Since John's weight increased from 29.0 to 49.7 in 5 years it increased 20.7 or 4.1

each year. So we can make a column of expected weights - successive items differing from the observed value of the previous year by this amount of 4.1 kg. (Table 7). Similarly, we can draw up a column of expected O_2 consumption. The a and b columns of Table 7 give the expected weight and expected O_2 consumption for comparison with observed weight and O_2 consumption respectively. The x and y columns give the departures from expectation of the a and b columns. They are used for the correlation in the formula:

$$r_{xy} = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{N}}{\sqrt{\left(\Sigma x^2 - \frac{(\Sigma x)^2}{N}\right)\left(\Sigma y^2 - \frac{(\Sigma y)^2}{N}\right)}}$$

By this method Σx and Σy are $0 \pm \frac{N}{2}$ and are so small that they may be ignored. Then the formula becomes:

$$r_{xy} = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \, \Sigma y^2}}$$

The number of intervals in each correlation ranged from 4 to 6.

TABLE 7

LAYOUT OF DATA OF NO. 4848 AS PREPARED

FOR "INDIVIDUAL" CORRELATIONS OF WEIGHT AND O_2 CONSUMPTION

a	Wt.	x	b	O_2	y	x^2	y^2	xy
	290			159				
331	331	0	173	172	-1	0	1	0
372	375	3	186	166	-20	9	400	-60
416	389	-27	180	175	-5	729	25	135
430	445	15	189	192	3	225	9	45
486	497	11	206	229	23	121	529	253
		2			0	1084	964	373

An alternative method of computing "individual" correlations using the data of Table 7, is shown in Table 8.

TABLE 8

ILLUSTRATING ALTERNATIVE METHOD OF COMPUTING "INTRA-INDIVIDUAL" CORRELATIONS

Wt.	x	O_2	y	x^2	y^2	xy
290		159				
331	41	172	13	1681	169	533
375	44	166	-6	1936	36	-264
389	14	175	9	196	81	126
445	56	192	17	3136	289	952
497	52	229	37	2704	1360	1924
	207		70	9653	1944	3271

The data of Table 8 are arranged as in Table 7 and the differences between successive measurements correlated.

In this case Σx and Σy are not 0 and must be used in the formula:

$$r_{xy} = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{N}}{\sqrt{\left(\Sigma x^2 - \frac{(\Sigma x)^2}{N}\right)\left(\Sigma y^2 - \frac{(\Sigma y)^2}{N}\right)}}$$

$$r = \frac{3271 - 2898}{\sqrt{1084.964}} = \frac{373}{1022} = 0.365$$

By the first method

$$r = \frac{373}{\sqrt{1084.964}} = \frac{373}{1022} = 0.365$$

The two methods take about the same amount of time and give identical results.

Results of Correlation Computations
Values of Average Correlation Coefficients (r) Using
Departures from "Standards", Together With Standard Errors

1. Mass correlation between the difference betwixt two successive percentage departures from BM standards (cols. 8 or 10 of Tables 4 and 5) and change in stature increments for the same period.

a. Boys, using departures from Sanborn's standard (cols. 2 and 8).	+0.151 ∓0.70
a[1]. Boys, as in a, but using only O_2 consumption determinations that are included in b.[8]	0.327 ∓0.110
b. Boys, using departures from Harris and Benedict normals (cols. 2 and 10).	+0.362 ∓0.100
c. Girls, using departures from Harris and Benedict normals (cols. 2 and 10).	+0.252 ∓0.004

2. Mass correlation between the difference of two percentage departures from BM standards (cols. 8 or 10) and change in stature increments as given in col. 2 during the 3 months preceding the BM determination. The statures taken at the half year and resulting increments are not given in the Table.

a. Boys, using Sanborn's standards	0.181 ∓0.078
b. Boys, using Harris and Benedict standards	0.210 ∓0.122

3. Mass correlation between the difference of two percentage departures from BM standards (cols. 8 or 10) and change in increment of stature (col. 2) during the 3 months following the BM determinations. The statures taken at the half year and resulting increments are not given in the Table.

a. Boys, using departures from Sanborn standards	+0.146 ∓0.078
b. Boys, using departures from Harris and Benedict standards	+0.341 ∓0.101

4. Mass correlation between the difference of two successive percentage departures from BM standards (cols. 8 or 10) and the change in increment of stature (col. 2) during the 12 months following the BM determination.

a. Boys, using departures from Sanborn standards	+0.041 ∓0.065

5. Mass correlation between the difference of two successive percentage departures from BM standards (cols. 8 or 10) and the change in increment of weight during the same period as the BM determination.

a. Boys, using departures from Sanborn standards	+0.090 ∓0.075
b. Boys, using departures from Harris and Benedict standards	+0.208 ∓0.108
c. Girls, using departures from Sanborn standards	+0.011 ∓0.071
d. Girls, using departures from Harris and Benedict standards	-0.001 ∓0.102

[8] *Standards for certain ages that are present in the Sanborn table are missing from those of Harris and Benedict.*

The data on departures from Sanborn standards are somewhat more complete than those from Harris and Benedict standards.

Distribution of Frequencies of Values of Intraindividual Correlations Between Departures of Observed from Expected O_2 Consumption and Departures of Observed from Expected: (a) Stature, (b) Weight and (c) Body Build, All in Cases Compared for the Same Period of Time

6. a. Statures	32 males	38 females
Average of intraindividual correlations	0.036 $\mp$0.098	0.323 $\mp$0.080
Standard deviations	0.538	0.486
Mass cor's (r) between the departures	0.356 $\mp$0.069	0.256 $\mp$0.068
7. b. Weights, in kg.	31 males	38 females
Average of intraindividual correlations	0.277 $\mp$0.062	0.332 $\mp$0.073
Standard deviations	0.341	0.444
Mass cor's (r) between the departures	0.277 $\mp$0.075	0.428 $\mp$0.059
8. c. Body build, (wt/ht^2)	31 males	38 females
Average of intraindividual correlations	0.156 $\mp$0.076	0.255 $\mp$0.102
Standard deviations	0.429	0.622
Mass cor's (r) between the departures	0.185 $\mp$0.077	0.365 $\mp$0.062

The frequency distributions of the intraindividual correlations between stature, weight and body build are shown graphically in Figures 5 - 7.

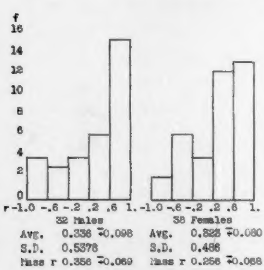

Fig. 5. Distribution of frequencies of values of "individual" correlations between departures of observed from expected statures and observed from expected O_2 consumption.

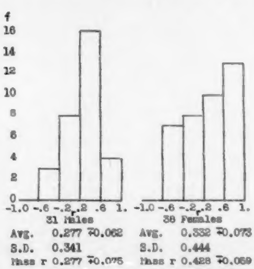

Fig. 6. Distribution of frequencies of values of "individual" correlations between departures of observed from expected weights and observed from expected O_2 consumption.

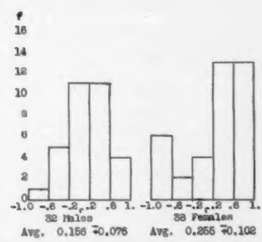

Fig. 7. Distribution of frequencies of values of "individual" correlations between departures of observed from expected body build (Wt/Ht^2) and observed from expected O_2 consumption.

Special Mass Correlation of Intraindividual Departures

When the correlations were computed from individual base lines between deviation of body build $(wt \div ht^2)$ and of oxygen consumption, it was apparent that there was a higher correlation in the variations when the body build was high than when it was lower. To get a rough measure of the correlation, tables were made of all the data derived from all persons measured who had body build index of 1800, or over, and a second set for those below 1800, for males and females. In most cases the same individual was used in both tables as his body build index changed. The corresponding deviations from base line of body build (<u>x</u> values) and deviations from base line of O_2- consumption (<u>y</u> values) were used from the individual correlations of $wt \div ht^2$.

9. Mass correlations between deviations of <u>body build</u> and of O_2 consumption in those cases only whose <u>body build</u> was 1800 or over, using departures from

individual's base lines.

a. Boys	average	0.228	∓0.090
b. Girls	average	0.483	∓0.067

10. Mass correlations between deviations of <u>body build</u> and of O_2 consumption in those cases only whose body build was under 1800, using departures from individual's base lines.

a. Boys	average	0.092	∓0.042
b. Girls	average	0.079	∓0.112

In a normal adult a decrease in weight is accompanied by an increase in basal metabolism and vice versa, giving a high negative correlation between change in weight and B.M. The positive correlation we have obtained must then be due to the process of growth. To bring out more clearly the growth effect, average correlations were computed using only the values of height where departures from average growth were over 10 mm. per year and of weight over 2.5 kg. per year. The remaining data were used as control comparison.

11. Mass correlations between deviations from expected <u>stature</u> change and of O_2 consumption change in those cases only in which the deviations were ± 10 mm. per year or over.

a. Boys	average	0.4082	∓0.0869
b. Girls	average	0.3556	∓0.0725

12. Mass correlations between deviations from expected <u>weight</u> change and of O_2 consumption change, in those cases in which the deviations were ±2.5 kg. per year or over, (cases <u>a</u> and <u>b</u>) or less than ±2.5 kg. per year (cases <u>c</u> and <u>d</u>).

a. Boys ± 2.5 kg. per year or over	0.4392	∓ 0.116
b. Girls ± 2.5 kg. per year or over	0.6728	∓ 0.065
c. Boys under ± 2.5 kg. per year	0.0063	∓ 0.085
d. Girls under ± 2.5 kg. per year	0.0073	∓ 0.081

c. Percentage of Basal Metabolism Due to Growth as Measured by the Excess of O_2 Consumed During the Spurt of Growth (Figure 8)

First, in order to eliminate the effect of weight variations upon O_2 consumption, the amount of oxygen consumed per kilogram of body weight was determined for some of the tallest, most rapidly growing individuals. When the data were graphed, it was seen that this ratio decreased steadily as the subject grew older, so a base line was drawn through two points selected so that all of the other points were above the line (fine oblique line). It is here assumed that these points have a minimum value with respect to growth processes and the excess of oxygen consumption at the other points is due to growth processes. It must be clear that, because of this, the results obtained are too small, by an indeterminable amount, to give the total amount of O_2 consumption concerned primarily with growth. A similar set of curves (broken line) was made for stature as measured, and the percentages of O_2 consumption were computed where the growth curve had the largest excess. The percentage of metabolism due to the spurt of growth was determined from the excess of oxygen consumed at this time divided by the value of the base line at the same age. The results obtained are given in Table 9.

From Table 9 it would appear that the excess of oxygen consumption is, on the average, about 11 per cent, so we may infer that the oxygen utilized for growth processes is, at the time of the more active adolescent spurts, at least 10 per cent of all oxygen consumed.

Table 9, giving for the curves of Figure 8: (1) the number of the figure, (2) the excess of oxygen consumed at the time of fastest growth, (3) the corresponding value of the base line, (4) the percentage quotient of (2) divided by (3).

(1)	(2)	(3)	(4)
3717	0.40	4.10	9.76
4227	0.55	3.70	14.86
4120	0.38	4.48	8.48
4263	0.40	4.20	9.52
3720	0.80	3.78	21.16
3363	0.12	4.56	2.63
		Total	66.41

Talbot, Wilson and Worcester (1937, p. 56) cite the case of a girl measured during 14 months, whose total calories increased at the time of the adolescent spurt from 2014 to 2140 and then fell to 1618. They conclude that "the metabolism of the child who grew in height faster than the average before puberty was 5 per cent higher than the average."

D. DISCUSSION

Basal metabolism is defined, as we have seen, "as the sum of all the vital activities of the quiet organism in the post absorptive condition." These residual "vital activities" fall obviously into many categories. There is one category that is present in the growing organism that is not present in the organism that has stopped, or nearly stopped, growing - that is the category of growth. And the vital processes of growth are of great importance in an organism like the new-born infant that may double its weight in the first post natal year and some years later may add 7 to 15 centimeters (5 to 10 per cent) in stature and 8 to 10 kilograms (15 to 25 per cent) in one year during the adolescent spurt. Clearly such a vital process superimposed upon the others must be responsible for a large proportion of the basal metabolism of the growing period. Can we determine what proportion?

This study attempts to gain light on the matter by comparing basal metabolism before, during and after the spurt of growth in about 100 individual boys and girls. The spurt of growth occurs at a time of life when the plateau of basal metabolism has been nearly reached except for the adolescent spurt. The infantile period, with its restlessness, is passed, even the slight and variable juvenile acceleration is finished, the general curve of basal metabolism is well established on its declining slope. Now, if there is evidence of a temporary increase of metabolism associated with the adolescent spurt of growth, that increase gives a measure of the extra metabolism that is incurred in the vital activities of growth. The correlation between increase in size of body and of basal metabolism during the period of the adolescent spurt that yields the highest value is obtained in the cases of boys and girls who gained in weight 2.5 kilograms per year or over. This is, remarkably enough, somewhat greater than in the case of boys and girls to whom the deviations in stature change were ±10 millimeters per year. Also the correlation in weight is greater in girls than boys, as 67 is to 44, and since this difference is more than twice the standard error it is probably significant. That is to say, girls who increased unexpectedly rapidly in weight consumed more nearly a corresponding excess of oxygen than did boys. This is though the increased weight of the girls demanded an increase of oxygen consumption proportionally greater than that of the boys. A similar difference between the sexes is found in the cor-

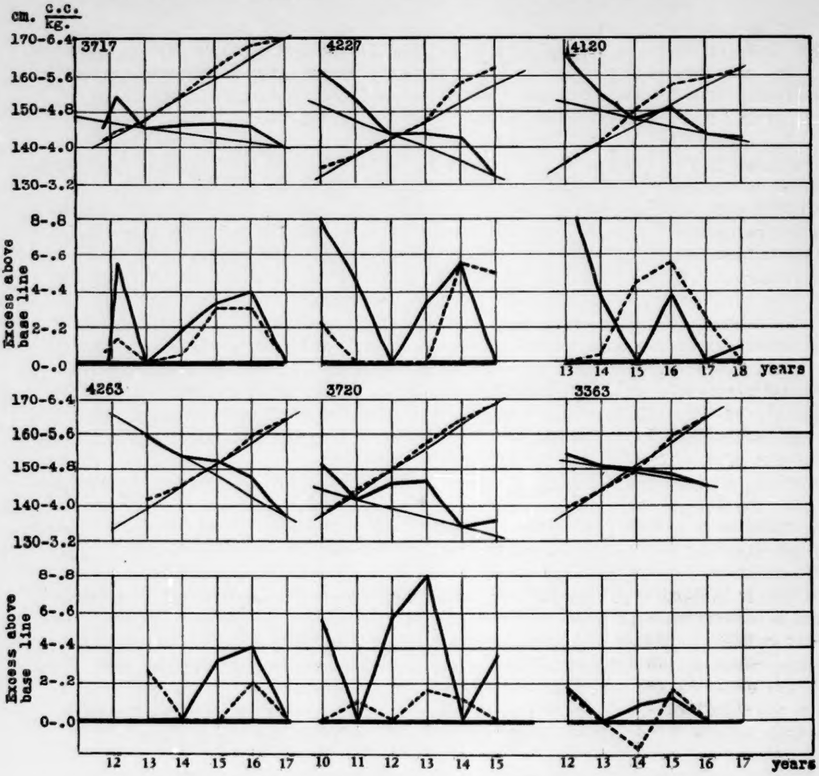

Fig. 8. Six pairs of sets of graphs showing relation between stature, weight, excess stature and excess weight, on the one hand, and oxygen consumption on the other, for six individuals whose institutional numbers are given in upper left hand corner.

In each pair of graphs the upper portion shows: ------- stature in cm. (scale to left). _______ O_2 consumption in c.c. per kilogram of body weight (scale to left). _______ Base lines from which were measured excess stature and excess O_2 consumption.

In each pair of graphs the lower portion shows: ------- excess of stature determined from base line of upper portion. _______ Excess of O_2 consumption determined from base line of upper portion.

relations between body build of over 1800 and O_2 consumption. The correlations are not so great but the correlation in the female is more than twice that in the male and the difference is 2.3 times the square root of the sum of the squared standard errors. These sex differences are rather unexpected. The correlation between changes in stature and O_2 consumption shows no such difference between the sexes, and Talbot, Wilson and Worcester (1937, p. 21) find that percentage rate of annual growth in weight is four times as effective in increasing heat production estimated from the weight as is percentage increase in height from the standard.

It is noteworthy that where the increase of weight is less than 2.5 kg. per year above or below expected there is no significant correlation with O_2 increase.

The mass correlation between the difference betwixt two successive percentage departures from BM standards and change in stature is slightly larger in boys than girls, but the difference is statistically insignificant.

The correlation in boys between the difference of two successive percentage departures from BM standards and change in stature during three months following the BM determination is probably significant; is certainly higher than the correlation with the 3 months preceding and about the same as the correlation with BM determinations taken at the same time. We may conclude that the increase of basal metabolism may precede, as well as occur at the same time as, the increase in stature.

The point might be raised that the increased metabolism is not due directly to the demands of increased growth. It is well known that the thyroid gland of adolescent girls tends to become enlarged. A more active thyroid means higher metabolism. But matters are not so simple as this. First, boys also show increased metabolism without showing enlarged thyroids. Also, in girls increased activity of the thyroid without any accompanying (or resultant) increase of growth would tend to slenderness of body. Despite, perhaps because of, increased activity of the thyroid these girls grow exceptionally rapidly in stature and weight at adolescence. Increased growth is associated with increased O_2 consumption. The intermediate processes involved between O_2 consumption and growth are doubtless many and varied. Very likely thyroid metabolism is one of them. Involved also are the secretions of the pituitary gland. We cannot at this time discuss these intermediate processes since they are so imperfectly known.

The intraindividual correlation between departures of weight and departures from metabolic base line are slightly larger than the correlation with BM standards; but the sexual differences are in neither case significant. The correlation between stature departure and metabolic departure from individual base lines are the same for the sexes and not significantly different from the correlation with the BM standards. In general the correlations are not markedly different whether reference is made to mass standards or to individual base lines.

SUMMARY OF CONCLUSIONS

A study was made of changes in basal metabolism associated with changes in physical growth, made "longitudinally" upon 55 boys and 55 girls measured before, during and after the adolescent spurt of growth.

Correlation of departures is computed both from a mass "standard" and from the individual's own base line; the two methods giving about the same result.

When reference is made to mass standards the correlation is usually low, not over 0.36, is possibly higher for stature than weight, and about the same for boys and girls.

The change in rate of basal metabolism probably slightly precedes the spurt of growth in stature. The highest correlations are found when the changes in stature or weight to correlate with changes in basal metabolism are selected for their large size. There are basal metabolic processes concerned in growth of the body that during the period of the adolescent spurt of growth amount in selected cases to at least 10 per cent of the total basal metabolism.

The correlations between body build departures and those of basal metabolism from individual base lines are so low as to be insignificant; certainly increasing obesity is not correlated with increasing basal metabolism even though increasing weight of the body as a whole is.

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ABSTRACT

A study was made of the correlation between changes in percentage departure from standard basal metabolism (B.M.) and changes in speed of physical growth studied "longitudinally" on some 55 boys and 55 girls over a period of from 5 to 8 years, before, during and after the adolescent spurt of growth.

Mass correlations were mostly low, not over +0.36. Intra-individual correlations vary from -1.00 to +1.00. The averages of such intra-individual correlations are a little higher between B.M. and body weight than between B.M. and stature. The correlation between excess of body build and of O_2 consumption is high, 0.483, for girls; but not for boys. The highest correlation obtained (0.67) is between B.M. in girls whose weight change amounts to ±2.5 kg. per year deviation from expected gains. Thus during the adolescent spurt the increased B.M. processes associated with increasing weight may amount to 10 per cent or more of the basal metabolism as determined before and after this spurt.

THE PREDICTIVE VALUE OF INFANCY TESTS IN RELATION
TO INTELLIGENCE AT FIVE YEARS

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The efficiency of a psychological test is ordinarily judged by its ability to predict achievement in an educational or vocational field or on other tests which have been validated against some criterion of proficiency. Studies of the relationship of tests in infancy and early pre-school period to late achievement do not exist, and those which have been published using scores of tests at some later age as the criterion have consistently pointed to only slight relationships. Bayley (1) using a group of 61 children, reports correlations ranging from +.10 to +.39 between the performance on tests at four, five, six and seven, eight, nine months and performances at eighteen, twenty-one, twenty-four and twenty-seven, thirty, thirty-six months. Fillmore's (2) correlation of +.320 was obtained by relating performance at six months with the earliest IQ obtained. Muehlenbein (3) reports a coefficient of +.11 of scores on the Linfert Hierholzer test at six months and IQ standing at four and five years. Nelson and Richards (4), using thirty-one cases, give coefficient of +.47 between the Gesell six-month score and the Stanford-Binet mental age at thirty-six months.

There are several possible explanations for the low degree of relationships cited. Later intelligence may involve complex functions which may not have appeared at one year, or which have little or no representation in an infant's behavior repertoire. Also, motivational factors, such as the incentive of competition, desire to do well and compliance with a testing routine, are absent in the infant period. Before eighteen months the test item itself must have enough intrinic interest to capture the child's attention since verbal instructions are impossible. Furthermore, the stimulus value of a toy may not be the same for all children, for example, the presentation of the inch cube may stimulate one child to build a tower and another child to knock one block against another.

Statistically, the simple addition of point scores without regard to the predictive value of the individual test items may result in the favorable effects of the significant items being overbalanced by the unfavorable effects of the nonsignificant items. These last may not only act as dead wood, but may decrease the predictive value of a test (5).

Test construction for children under five years, and particularly under two years of age, has started with the assumption that items which show an increasing percentage of success with increasing age are satisfactory. Sometimes, as in the case of Bayley, (op. cit.) a priori judgment as to whether or not an item tests intelligence was used. This procedure differs very markedly from that followed for tests at older ages in which the percentage of successes at each age is used as supplementary to some outside criterion, such as school success.

The problems of this study are: first, to determine the efficiency of an infant scale constructed by the percentage of success method at three, six, nine, twelve, eighteen and twenty-four months in predicting five-year Stanford-Binet status; second, to determine whether a more efficient test can be secured by an item selection method using the five-year mental age status as the criterion; third, to determine the possibilities of combining scores at various ages for predicting later intelligence by applying multiple correlation procedures. The three sections of this report take up these problems in turn.

[1]*From Developmental Health Inquiry of the Associated Foundations, Western Reserve University, Cleveland, Ohio.*

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PROBLEM I

THE PREDICTIVE EFFICIENCY OF AN INFANT SCALE COMPOSED OF ITEMS SELECTED BY THE INCREASE IN PERCENTAGE OF SUCCESSES WITH AGE

The subjects. The subjects of the study were children enrolled in the Developmental Health Inquiry for serial examination at three-month intervals from three to twelve months, at six-month intervals from twelve months to five years, and at yearly intervals thereafter.

The records of ninety-one children who had been examined at all specified age periods from three months to five years were used. With few exceptions tests were given within two weeks of ages. The tests were given and scored by well trained psychological examiners[2] under the direction of the writer. The average IQ of the group at five years was 116.12, with a range from 82.5 to 149.0 points.

The children were drawn from superior homes as judged by ratings on family socio-economic status. This research group is therefore superior to the general five-year population both in average IQ and in socio-economic status. Because of the curtailed range, the correlation coefficients later reported are probably the minimum expression of the true relationships.

Selection of test items. The infant tests consisted of most of the items from Gesell (6, 7), Bühler (8), and Linfert and Hierholzer (9), and in addition, certain items developed by the writer. The items were of a varied nature since the original purpose of the test was to measure as many phases of infant development as possible. The original scoring method was based on Gesell's four category classification of motor, adaptive, personal-social and language.

Results. In this study correlation coefficients were secured between the scores on the baby tests and the five-year IQ (status). That is, the usual (point addition) method of scoring by adding one point for each test passed was used. These results are directly comparable to those appearing in the literature. Correlation coefficients for the ninety-one cases are given in Table 1. The figures in column 1, (total score), are directly comparable to those reported by other investigators. In general these results check with previous findings, in that there is little or no relationship between scores at three, six, nine and twelve months and later IQ standings. The probable error of a .00 coefficient with ninety-one cases is ±.071. None of the coefficients at three to twelve months exceed this figure. The eighteen-month coefficient of .231 is over three times the P.E. and is probably significant.

The results indicate that an infant scale constructed only with regard to the inclusion of items which show an increasing percentage of success with age

TABLE 1

CORRELATION COEFFICIENTS INFANT SCALE SCORES (3-24 MONTHS) AND FIVE-YEAR IQ STATUS

Ages	N	Total score	Motor Items	Adaptive items	Personal Social items	Language items
3 mos. - 5 yrs.	91	.008	.012	.042	.050	.066
6 mos. - 5 yrs.	91	-.065	-.060	-.029	-.140	.046
9 mos. - 5 yrs.	91	-.001	.100	-.022	-.043	-.107
12 mos. - 5 yrs.	91	.055	.112	-.017	.074	-.002
18 mos. - 5 yrs.	91	.231	.071	.246	.065	.224
24 mos. - 5 yrs.*	91	.450	.133	.331	.214	.453

*The twenty-four month test used here does not contain the items from the Merrill Palmer or the Stanford-Binet test.

[2] *Elizabeth Ebert, Marjorie Addison, Dr. Evelyn Katz.*

has no value in predicting intelligence, as measured by tests given four to four years nine months later.

A study of the columns for the four subclassifications indicates some important trends. The adaptive and language scores at eighteen and twenty-four months show significant relationships, although they are not of such magnitude as to warrant their use for prediction.

Of great interest is a comparison of the change in the size of the coefficient for the language and adaptive classifications with an increase in the age of children tested. Both these classifications, and to a lesser extent the personal-social group, involve the comprehension of language symbols.

Early language development (eighteen - twenty-four months) appears to be more closely related to later intelligence test scores than any other grouping of tests. A tentative conclusion may be drawn, namely that the best indication of intelligence at eighteen and twenty-four months of age is development in the use and understanding of language. Furthermore, the results may suggest the impossibility of predicting later intelligence (as it is measured by our typical intelligence tests) before the age when language development can be measured. Further data on this point are presented in the analysis of results of the next problem.

PROBLEM II

MODIFICATION OF THE INFANT SCALE BY ITEM ANALYSIS

The subjects. The same ninety-one cases were used in this study as were used in the previous one with the addition of nine children who had been given the Stanford-Binet test at five years after the completion of the first study. This addition did not change the characteristics of the group.

The tests. No change was made in the tests, except that the items of the Merrill Palmer and the Stanford-Binet were added to the twenty-four-month scale.

Procedure. Two dichotomous groups of five-year-old children representing divergent intelligence test ratings were formed: the fifteen children with the highest IQ at five years were placed in the superior intelligence group, the fifteen with the lowest IQ were placed in the inferior intelligence group. Each item of the test batteries was critically examined with respect to the number passing and failing in each of these two groups at each age. The most diagnostic items were selected first and the correlation coefficient of the particular age test scores and five-year test status for the entire group was secured. Also, the odds-evens reliability coefficients were calculated. Less significant items were then added until the largest predictive coefficients and the highest odds-evens reliability were secured.

The total number of test scoring items studied by this method and the number of selected items were as follows:

	Total number of items	Number of selected items
3 months	85	9
6 months	116	16
9 months	110	9
12 months	97	5
18 months	115	18
24 months	183	46

The number of items at each age which had some significance when checked against the two validating five-year IQ groups is low when compared to the total number

of items studied. This is not surprising since the Gesell test and the other infant scores from which these items were selected were designed to measure other phases of development in addition to intelligence. It is very possible that many of these discarded items would have considerable value in predicting other types of five-year behavior such as motor ability or social adaptability.

Results.

1. Test items selected by the item analysis technique.

Three months:

Laughs aloud, sound play, rolls back to side, lifts head spontaneously dorsal position, manipulates red ring, follows saucer with eyes as it disappears, regards spoon when held quiet, recovers rattle in each reach, turns head to side when examiner places finger on chin.

Six months:

Eh, ooh, eeh sounds, displeasure on withdrawal of object, rolls back to side and back, rolls back to stomach, elevates self on one arm while on stomach, lifts head and shoulder spontaneously dorsal position, coordinated pushing when head is held firmly, partial thumb opposition in holding rod, partial or complete thumb opposition when holding block, reaches for paper, when in sitting position regards pellet, satisfaction (vocal) in attaining object, sits without support, grasps dangling red ring, looks for fallen spoon, throws objects to make noise.

Nine months:

Partial finger prehension grasping pellet, pulls self to standing position by chair, fine finger prehension grasping pellet, raises to sitting position to secure toy, lowers self gradually from standing to sitting position, uses string to obtain red ring, reaches for string on red ring, imitates beating of two spoons, plays with mirror image.

Twelve months:

Imitates sounds, reacts to question "where is mother," places cubes into cup, uses spoon, asks for things by pointing.

Eighteen months:

Gesell test items: accepts four cubes, uses spoon, places square or triangle in formboard without being shown, builds tower of four blocks, names third watch picture, secures toy from specimen case upside down, knows where he wants to go, turns pages of book, asks for toilet, names two pictures, obeys two prepositions, gives first name, obeys two commands.

Merrill Palmer test items: straight block tower of three (or two on two), thirteen or more cubes placed in sixteen cube box, sixteen cubes in box in 125 seconds or less, Wallin Peg Board A best trial 25 seconds or less.

Twenty-four months:

Gesell test items: crosses feet (imitation), stands on one foot (imitation-command), imitates walking block, solves dissected pictures, solves formboard one minute, solves formboard one error, attempts to build bridge of three blocks, solves formboard one minute no errors, adapts to formboard reversal one minute, shows interest in stories, puts on shoes, cleans teeth, names pictures, repeats four of four words, repeats three to four syllables, gives first name, points to pictures, names three of five objects, uses pronouns, tells experiences, gives full name, gives sex, uses color names, points to seven or more objects, knows one color, counts to two or three.

Binet test items (1916 revision): names objects, gives names, repeats syllables.

Merrill Palmer test items: walks block (imitation), identifies self in mirror, sixteen cubes in box in 125 seconds or less, nests cubes in 250 seconds or less, answers six to ten questions, cuts with scissors, repeats word groups

(ten or fourteen words), matches colors, Sequin Formboard two of three trials complete, Wallin Peg Board B (27 seconds or less best trial), Sequin Formboard (222 seconds or less best trial).

2. Age changes in the characteristics of significant items. The measure of significance here used, namely difference in percentage of the number of children passing each item in two widely divergent groups, indicated that the items at eighteen and twenty-four months are much more discriminative than the items at the earlier ages. Part of this increased significance is undoubtedly due to the diminishing difference in time between tests at eighteen and twenty-four months and those at five years. Much of it is due to the verbal character of the test items at the latter ages.

The most marked characteristic of the significant items at three months is alertness to external environmental stimulation. Five of the nine items are classified by Gesell as adaptive behavior. Two of the other tests involve vocal reactions. This same characteristic is evident in the six-month items, particularly those which involve bodily orientation, such as rolling and raising head. Items involving manipulation of objects in an exploratory way also occur. That is, for these two ages the behavior prognostic of later intellectual development is characterized by positive reactions to happenings in the immediate field of the child with a beginning interest in contactual exploration of objects.

The occurrence of only a few significant items at nine and twelve months may be due to the selection of items, or to a definite change in the growth pattern at these ages.

The selected items at eighteen and twenty-four months are largely concerned with the development of language habits and the acquisition of skills later tested by the Merrill Palmer scale. Twenty-six of the forty-six significant items of the twenty-four - month series fall into the general category of language. Briefly, the significant items change in character from awareness or alertness at three and six months to language responses and the acquisition of skills in response to environmental stimulation at eighteen and twenty-four months.

The correlational analysis in the first study and the analysis of the characteristics of significant items both point to the major role that language development has in the prediction of success on intelligence tests at a later age. The most significant early indicator of future intelligence appears to be the acquisition of language habits, both in terms of use and understanding of language symbols.

3. Reliability and validity of revised test. Table 2 contains the odds-evens correlation coefficients corrected by use of the Spearman Brown Prophecy formula, (underlined and in the diagonal) and the intercorrelations of the three, six, nine, twelve, eighteen, and twenty-four - month test scores and five-year mental age. The reliabilities of the three, six, nine and twelve-month

TABLE 2

RELIABILITY* AND VALIDITY OF MODIFIED INFANT SCALES

Age in Months	3	6	9	12	18	24	5 yrs. 60
3	.660	.592	.378	.206	.241	.341	.315
6		.601	.379	.397	.347	.303	.413
9			.631	.234	.314	.363	.202
12				.507	.451	.469	.200
18					.885	.484	.365
24						.913	.550

*Odd-evens coefficients corrected by the Spearman Brown Prophecy formula, underlined.

tests are low, all being in the neighborhood of .60. This contrasts with the figures given by Bayley, op. cit. page 35, which show reliabilities in the neighborhood of .90. This difference is probably due to the inclusion of many more items in the Bayley study. In other words, high reliability may be obtained by the inclusion of a great many items, even though the items in themselves are not significant indicators of later intelligence ratings.

The possibility of increasing these reliabilities and still maintaining the validities as expressed is slight, since the items used in the original test contained most of the items at present available, and the field appears to have been well surveyed. However, the data were treated with the Spearman Brown Prophecy formula to determine how many items would be needed in order to bring the reliability of each age test up to .90 (Table 3). The particularly high number of items at six months may be explained by the possibility that the same function may have been measured by two or more items. In the construction of the test, the intercorrelation between items was not considered since the problem of the study was not to secure the highest validity with the least number of items, but to secure the best predictive tests with the items used. This also may account for the greater number of items at twenty-four months.

The last column in Table 2 contains the coefficients of each test up to twenty-four months and five-year Stanford Binet achievement. The three and six-month coefficients have considerable theoretical value since they indicate a relationship between test performance and achievement on a test, given four and a half years later, predominantly based on understanding of directions and verbal responses. In the light of the previous conclusion as to the significant role that language development plays in the prediction of later intelligence, there appears to be a definite indication that adaptation to the environmental stimulation in the early months of life plays an equally important role.

The relatively low correlations at nine and twelve months may be due to the small number of significant items which would cause lack of discrimination between individuals or may be due to a change in the growth pattern itself. However, the results show significant relationships between three, six, eighteen and twenty-four-month test status and status at five years.

In Table 4 the results are collated to indicate the change in validity by the item analysis. Column 1 contains the coefficients before the item analysis; column 2, the results after item analysis using the significant items; column 3, the results using only the nonsignificant items; columns 4 and 5 contain the data for the tests before and after validation but eliminating the thirty cases forming the dichotomous groups used in the item analysis procedure.

A comparison of columns 1 and 2 shows the increased efficiency of the infant scale when only the significant items were used, and indicates the value of a study of test item significance in the construction of infant scales of development. Column 3, containing the coefficients using only the nonsignificant items, represents a check on the item analysis procedure, in that all of the valuable material in the original scale had been abstracted by the statistical

TABLE 3

NUMBER OF TEST ITEMS NEEDED TO GIVE TEST RELIABILITIES OF .900

Age Test	Original r's	Number of items in test	Number of items needed to raise reliability to .90
3 mo.	.660	9	42
6 mo.	.601	16	96
9 mo.	.631	9	47
12 mo.	.507	5	35
18 mo.	.885	18	47
24 mo.	.913	46	39

TABLE 4

INCREASE IN TEST VALIDITY BY ITEM ANALYSIS TECHNIQUE CRITERION - FIVE YEAR STANFORD-BINET M.A.

	Including validating group			Eliminating validating group	
	Test before item analysis	After item analysis Selected items	After item analysis Non-significant items	Test before item analysis	After item analysis Selected items
Test age	(1)	(2)	(3)	(4)	(5)
3 mos.	+.086	.315	-.062	.016	.144
6 mos.	+.042	.413	-.028	-.021	.148
9 mos.	.084	.202	.028	.072	.178
12 mos.	.085	.225	.085	.061	.108
18 mos.	.200	.365	.158	.126	.179
24 mos.*	.523	.550	.410	.250	.309
N	100	100	100	70	70

*The twenty-four-month test in this study includes the items from the Merrill Palmer and Stanford-Binet scales.

technique, with the possible exception of the twenty-four-month test. An examination of the coefficients at twenty-four months shows that the significance of the test has been increased by the exclusion of the less significant items.

The figures in the last two columns need some explanation. Elimination of the two validating groups, i.e. the fifteen lowest and the fifteen highest IQ children, actually meant that the five-year mental age range had been restricted from forty-nine to eighty-nine M.A. months to sixty to eighty M.A. months. As expected this range curtailment resulted in much lower coefficients, but it is significant to note that the figures in column 5 are much higher than those of the original test without a curtailment of the range at three and six months and are approximately the same at twelve and eighteen months.

PROBLEM III

COMBINING TEST SCORES INTO TEST BATTERY

The foregoing data, while indicating some significant relationships, are not of such a nature as to warrant the use of the tests for prediction of later status except, perhaps, with extreme low or high deviations. The question arises as to the possibility of enhancing the forecasting efficiency by combining tests given at successive ages into a predictive battery.

Table 5 presents the multiple coefficients and the Beta weights as determined by the Doolittle method.

The results of the multiple correlation procedure indicate that the combination of three and six-month age tests increases the coefficient from .315 to .422, but adds nothing to the value of the six-month correlation itself. The addition of the nine and twelve-month age tests to this combination adds nothing to the value. The inclusion of the eighteen-month test adds five points to the multiple r, and the addition of the twenty-four-month age test increases the correlation to .64. Practically a combination of the six, eighteen, and twenty-four-month test scores gives this multiple correlation of .64. Undoubtedly this value represents the maximum prediction possible, but it is to be remembered that the sampling here used was curtailed at the lower end of the intelligence range. In consideration of these factors it is reasonable to expect that the true relationship probably lies between .55 to .65, which is about the range of validity for most psychological tests in use at present.

TABLE 5

RESULTS OF MULTIPLE CORRELATION PROCEDURE
(CRITERION - 5-YEAR MENTAL TEST SCORES)

Age test combinations	Multiple correlation coefficient	Beta weights	
3 and 6 months	0.422	3 mo.	.109
		6 mo.	.349
3,6 and 9 months	0.423	3 mo.	.100
		6 mo.	.340
		9 mo.	.035
3,6,9 and 12 months	0.424	3 mo.	.103
		6 mo.	.323
		9 mo.	.030
		12 mo.	.043
3,6,9,12 and 18 months	0.474	3 mo.	.095
		6 mo.	.290
		9 mo.	-.016
		12 mo.	-.053
		18 mo.	.270
3,6,9,12,18 and 24 months	0.639	3 mo.	-.015
		6 mo.	.342
		9 mo.	-.103
		12 mo.	-.212
		18 mo.	.121
		24 mo.	.529

The possibility increasing these coefficients by the inclusion of nontest data such as parental education was explored. The coefficients of parental education and test scores are given in Table 6. The multiple correlation results of various age test combinations and parental education are given in Table 7.

TABLE 6

CORRELATIONS PARENTAL EDUCATION AND TEST SCORES

N = 100

Parental Education	Test Age 3	6	9	12	18	24	5 yr.
Mother	.109	-.113	.027	-.197	-.058	-.057	.252
Father	.102	-.034	-.030	-.141	.029	.051	.176

F and M Education .4822

TABLE 7

RESULTS OF MULTIPLE CORRELATION TECHNIQUE

Variable Combinations	Multiple r
M.E.* and F.E.**	.259
M.E., F.E. and 3 mos.	.403
M.E., F.E. 3 and 6 mos.	.519
M.E., F.E., 3, 6 and 9 mos.	.515
M.E., F.E., 3, 6, 9 and 12 mos.	.505
M.E., F.E., 18 and 24 mos.	.609
M.E., F.E., 3,6,9,12,18,24 mos.	.707

*Education of Mother
**Education of Father

The best correlation, .707 occurs with the use of all test variables and mother's and father's education. However, of great interest is the multiple r of .519, secured by the use of the two education variables and the three and six-month tests as compared to the zero order coefficient of .550 between the twenty-four-month test and five-year intelligence. That is, by the use of additional family data the value of the three and six-month tests has been increased to a point approximating the forecasting efficiency of the two-year test.

SUMMARY OF RESULTS

This investigation is an analysis of the validity of infant performance scales using five-year intelligence as the criterion. The first part of the study consisted of analysing the correlations of scores achieved at three, six, nine, twelve, eighteen and twenty-four months with five-year intelligence standing without determining the validity of individual items. The second phase of the study was concerned with a modification of the original test by making an item analysis using five-year status as the criterion. Finally, correlational data were analysed by the Doolittle multiple correlation technique to determine the validity of various age tests and parental education combinations.

The results of the first study indicate that the infant performance scale has little or no significance in predicting standing on intelligence tests at five years and substantiates the conclusions of earlier investigations. Of great importance are the data concerning the significant role that test items, involving the use of language and the understanding of words, play in the prediction of intelligence. For example, the correlation of a test composed of language items only is more significant than other classifications of items (see Table 1). Also there is a considerable increase in the size of the correlations for both the language test alone and the total test. This increase parallels the increased number of language responses included in the test items.

An item analysis using five-year Stanford-Binet scores as the criterion for group dichotomy resulted in the elimination of many non-significant items. The results indicated that while the reliabilities of the tests were lower than otherwise found, the validity of the tests was increased.

The study demonstrates that the item analysis technique increases the predictive value of the infant scales. The nine and twelve-month results, however, are definitely out of line with either those at three and six months or those at eighteen and twenty-four months. There is indication that tests given at three or six months or at eighteen months are much more valuable than those given at nine or twelve months. This may be due to the small number of significant items or to a change in the growth pattern itself.

Of great significance are the data with respect to the relationship of early test performance, before the advent of measurable language development, and intelligence test score four and one-half years later, in spite of the great development in skills during the period and necessarily the great dissimilarity in the constitution of the tests at the two age periods.

A combination of the three, six, nine, twelve, eighteen and twenty-four-month age test scores correlates +.64 with five-year intelligence. This coefficient falls in the upper range of validity coefficients for psychological tests at any age which usually cover a much shorter time span between predictive test and criterion.

The use of education of mother and father as variables in the multiple correlation procedure at twenty-four months resulted in a multiple correlation of .707.

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A NOTE ON "PHYSICAL PROPORTIONS IN THE HUMAN INFANT"

NEPHI JORGENSEN[1]

Carter, Harold D., and Krause, Ruth H., in 1936 (1) presented an analytic study of the interrelationships of various dimensions of the human body. Their data consisted of the intercorrelations obtained from 18 anthropometric measurements taken on 609 female newborns and 608 male newborns.

As part of their analysis Thurstone's simplified multiple factor method was applied to the data. Four factors were reported by them. Factor I was identified as a measure of size in general, producing factor loadings comparatively heavy for each of the 18 variables. Factor II represented a composite of contrast effects. The contrast involving length measurements and weight positively weighted, and the measurements of the face, hands, and pelvis negatively weighted. Factor III contrasted the height and width measurements of the smaller dimensions of the body. Factor IV was also a measure of contrast although less important than the first three factors.

One aspect of the study is questioned, however, in light of the fact that they did not rotate their factor loadings. As Thurstone points out, it is essential to rotate in order to obtain logically meaningful results (2).

THE PROBLEM

The purpose of this study is to rotate the factor loading and attempt to identify the emerging factors.

PROCEDURE AND RESULTS

The original factor loadings of Carter and Krause, presented in Table 1, were rotated according to Thurstone's directions. The rotated loadings are shown in Table 2.

TABLE 1

ORIGINAL UNROTATED FACTOR LOADINGS

	Factor I		Factor II		Factor III		Factor IV		Hyp.[2]	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1. Total length	.60	.73	.54	.52	-.07	.05	.06	-.09	.67	.82
2. Sitting height	.59	.65	.58	.51	.01	.03	.08	-.02	.70	.69
3. Bimalar diameter	.72	.68	-.08	-.12	.27	.25	.09	.24	.60	.60
4. Upper facial height	.58	.52	-.10	-.18	-.39	-.42	-.11	-.11	.52	.48
5. Height of lower jaw	.46	.39	-.01	.08	-.16	-.13	.14	.11	.26	.19
6. Height of nose	.56	.52	-.31	-.37	-.20	-.27	-.36	-.42	.57	.66
7. Breadth of nose	.63	.61	-.29	-.37	.15	.09	-.10	.03	.52	.52
8. Inter-inner canthus	.52	.55	.04	.04	.13	.00	-.04	.12	.29	.32
9. Length of ear	.53	.58	-.24	-.10	-.25	-.17	.28	.11	.48	.39
10. Breadth of ear	.54	.53	-.19	-.11	-.25	-.26	.20	.18	.43	.40
11. Biacromial diameter	.79	.74	-.06	-.00	.13	.10	.09	.05	.66	.56
12. Bi-iliac diameter	.68	.64	-.30	-.42	.33	.36	-.06	-.15	.66	.74
13. Circumference of thorax	.84	.85	-.09	-.06	.24	.22	.11	-.01	.78	.77
14. Length of palm	.65	.63	.14	.15	-.13	-.09	-.12	.01	.47	.43
15. Breadth of palm	.72	.72	-.11	-.02	.07	.11	-.11	.02	.54	.54
16. Length of middle finger	.75	.69	-.26	-.28	.05	.10	-.17	-.14	.66	.58
17. Leg length	.68	.67	.34	.34	-.07	-.06	-.04	-.18	.58	.60
18. Weight	.76	.74	.40	.36	.16	.13	.15	.03	.78	.70

[1] *From The State University of Iowa, Iowa City, Iowa.*

TABLE 2

ROTATED FACTOR LOADINGS

	Factor I		Factor II		Factor III		Hyp.[2]	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1. Total length	.81	.90	.01	.06	.01	-.02	.66	.81
2. Sitting height	.82	.82	.01	.01	-.08	-.03	.68	.67
3. Bimalar diameter	.45	.51	.63	.57	-.02	.00	.60	.55
4. Upper facial height	.39	.32	.25	.23	.54	.58	.51	.48
5. Height of lower jaw	.35	.37	.23	.10	.26	.20	.24	.18
6. Height of nose	.22	.21	.46	.43	.44	.51	.45	.48
7. Breadth of nose	.25	.29	.66	.64	.15	.21	.52	.51
8. Inter-inner canthus	.40	.48	.36	.28	.00	.14	.29	.30
9. Length of ear	.23	.43	.46	.32	.27	.34	.34	.38
10. Breadth of ear	.29	.38	.34	.27	.43	.41	.38	.36
11. Biacromial diameter	.53	.62	.59	.45	.10	.11	.63	.55
12. Bi-iliac diameter	.27	.30	.76	.80	-.01	.00	.65	.69
13. Circumference of thorax	.54	.68	.69	.61	.03	.05	.77	.77
14. Length of palm	.58	.61	.26	.20	.23	.20	.46	.43
15. Breadth of palm	.45	.60	.56	.46	.17	.10	.55	.54
16. Length of middle finger	.37	.42	.65	.62	.25	.19	.61	.57
17. Leg length	.73	.75	.18	.09	.11	.11	.58	.59
18. Weight	.82	.82	.30	.22	-.09	-.04	.77	.69

The results of this rotation reveal the presence of three significant factors for both male and female.

Factor I is present in all the variables, although most heavily loaded in total length, sitting height, weight, and leg length. The evidence seems to indicate that this factor represents general gross body size, with especial emphasis on the linear measurements.

Factor II, is most heavily loaded in the breadths and circumference variables (with the exception of the length of the middle finger). McCloy has termed this factor a "cross-sectional" growth factor (3).

Factor III tends to be associated with the head measurements, being largest in upper face height, nose height, and the ear measurements. The writer recognizes the fallacy of attempting to positively identify this factor. In view of the work of Scammon (4), however, the suggestion might be made that it represents a "neural" type of growth factor.

Factor IV contains no loadings high enough to be significant.

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